HELSTF
High Energy Laser Systems Test Facility

US Army Corps of Engineers
Fort Worth District

# ENERGY STUDY (EEAP) AT HELSTF

WHITE SANDS MISSILE RANGE, NEW MEXICO

## FINAL REPORT
## VOLUME I



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## ABBREVIATIONS

| | |
|---|---|
| A | Amperes |
| AMPS | Amperes |
| AHU | Air Handling Unit |
| ASHRAE | American Society of Heating, Refrigeration & Air Conditioning Engineers |
| BTU | British Thermal Unit |
| CFM | Cubic Feet Per Minute |
| CHW | Chilled Water |
| CND | Condenser Water |
| COE | U.S. Army Corps of Engineers |
| DB | Dry Bulb Temperature |
| DDC | Direct Digital Control |
| DHW | Domestic Hot Water |
| DRIP PF | Drip Proof |
| ECI | Energy Cost Index |
| ECO | Energy Conservation Opportunity |
| EFF | Efficiency |
| EMS | Energy Management System |
| EPEC | El Paso Electric Company |
| EUI | Energy Usage Index |
| °F | Degrees Farenheight |
| fc | Footcandles |
| FLA | Full Load Amperes |
| ft | Feet |
| GPM | Gallons per Minute |
| HELSTF | High Energy Laser Systems Test Facility |
| HP | Horsepower |
| HRS, hrs | Hours |
| HTG | Heating |
| HVAC | Heating, Ventilating & Air Conditioning |
| HW | Heating Water |
| HX | Heat Exchanger |
| HZ | Huitt-Zollars, Inc. |
| IAQ | Indoor Air Quality |
| KVA | Kilovolt Amperes |
| KW | Kilowatt |
| KWH | Kilowatt Hours |
| LCCID | Life Cycle Cost in Design |
| LED | Light Emitting Diode |
| LSTC | Laser Systems Test Center |
| MA | Mixed Air |
| MBH | 1,000 BTUs per Hour |
| MBTU | 1,000,000 BTUs (on life cycle cost analysis summary sheets only) |
| MMBTU | 1,000,000 BTUs |
| MCF | 1,000 Cubic Feet (gas) |
| M&O | Maintenance & Operations |
| MWH | Megawatt Hours |

| | |
|---|---|
| MZ | Multizone |
| N/A | Not Available or Not Applicable |
| OA | Outside Air |
| PC | Personal Computer |
| PF | Power Factor |
| RA | Return Air |
| RH | Relative Humidity or Reheat |
| RPM | Rotations per Minute |
| sqft | Square Feet |
| TC-1 | Test Cell No. 1 Building |
| TC-2 | Test Cell No. 2 Building |
| TEFC | Totally Enclosed Fan Cooled |
| ton | 12,000 BTUs per Hour |
| USAED | U.S. Army Engineer District |
| V | Volts |
| VAV | Variable Air Volume |
| VFD | Variable Frequency Drive |
| W | Watt |
| WB | Wet Bulb Temperature |
| yr | Year |

# I. EXECUTIVE SUMMARY

## A. Introduction

This energy conservation study was performed by Huitt-Zollars Inc., for the U.S. Army Engineer District (USAED), Fort Worth, under contract number DECAC 63-94-D-0015. The study was conducted at HELSTF on the White Sands Missile Range in New Mexico, between September 21, 1995 and April 28, 1996. The site survey, data collection and technical analysis were performed by John Carter, E.I.T, Denney Howard, P.E. and C.A. Pieper, P.E..

The purpose of the study was to perform a limited site survey of specific buildings at the facility, identify specific Energy Conservation Opportunities (ECOs) that exist, and then evaluate these ECOs for technical and economic feasibility. These ECOs were open to all methods of energy conservation which were reasonable and practical.

This survey was conducted with the assistance of many individuals at both HELSTF and White Sands Missile Range facilities. Special thanks are extended to all of them, including the following individuals:

Julian Delgado, Energy Manager, White Sands Missile Range
Bob Anderson, Facility Engineer, HELSTF
Larry Brooks, Facility Engineer, HELSTF
Frank Tapia, Mechanical Maintenance Technician, Aerotherm, Inc.

Any questions concerning this report should be directed to the Project Manager, Denney Howard, at Huitt-Zollars Inc., 512 Main Street, Suite 1500, Fort Worth, Texas 76102. Phone 817-335-3000.

## B. Buildings Studied

This study was performed on three separate buildings and HELSTF. Photos of the three buildings are provided on pages 10 and 11. The buildings are briefly described as follows:

| | |
|---|---|
| LSTC Building: | This four story, mostly underground, domed structure serves as the laser systems test control center. The building is generally occupied Monday through Friday, between 7:00 a.m. and 5:00 p.m. |
| Test Cell # 1 (TC-1) | This four story, metal building serves as the laser system testing facility. The building is lightly occupied, unless in a testing mode, by scientists and technicians Monday through Friday, between 7:00 a.m. and 5:00 p.m. |
| Test Cell # 2 (TC-2) | This two story building serves as the central thermal energy plant for the test cell area (including TC-1). The building houses the central chiller and boiler systems, compressed air systems and distilled water systems for the test cell area. |

C. Present Energy Consumption

*Base Year Energy Consumption*: The total metered electrical and gas consumptions for 12 consecutive months, prior to the study, were obtained from the facility and are referred to as the 'base year.' This 'base year' data represents the consumption for the entire base as well as the buildings in this study. Refer to Figure 1 for a summary of the energy usage shown on Page 18 representing the monthly break-down for electricity, propane, and natural gas.

**Figure 1. Base Year Energy Usage By Source**

| Energy Source | Annual Usage | | Cost $ |
|---|---|---|---|
| Electricity | 13,281 MWH | 45,328 MMBTU | 1,068,842 |
| Diesel | 124,967 gallons | 17,332 MMBTU | 121,218 |
| Propane | 51,115 gallons | 5,352 MMBTU | 35,475 |
| Total | | 68,012 MMBTU | 1,225,535 |

*Building Energy Consumption*: The annual energy consumption for the lighting and mechanical systems (other than testing equipment) in the buildings studied was calculatedin Appendix G, using the Trace 600 computer program to model the lighting and HVAC systems. As one can see from Figure 2, This consumption amounted to a total of 34% of the base year energy usage and 46 % of the energy costs. These systems energy consumptions are given as follows:

**Figure 2. Annual Lighting and Mechanical Systems Energy Consumption**

| Building | Lighting & Mech. Systems Electricity KWH/YR | Lighting & Mech. Systems Electricity $/YR | Mechanical System Diesel Gallons/YR | Mechanical System Diesel $/YR |
|---|---|---|---|---|
| LSTC | 4,024,068 | 342,851 | 0 | 0 |
| TC-1 & 2 | 2,089,045 | 177,987 | 13,553 | 13,146 |
| Subtotals | 6,113,113 | 520,838 | 13,553 | 13,146 |
| Annual Lighting & Mechanical Systems Energy | | | 22,735 | MMBTU/YR |
| Annual Lighting & Mechanical Systems Cost | | | 533,984 | $/YR |

D. Energy Conservation Opportunity (ECO) Analysis

*ECOs Rejected:* After reviewing the data collected at the facility and considering all of the practical limitations involved, there were some suggested ECOs which were rejected prior to performing calculations. These ECOs are described below, with their reasons for rejection.

1. *Improve Power Factor*: An analysis of the electrical utility billing rate was made and is

have a power factor penalty clause. Therefore, the facility is not paying extra for a low power factor which may or may not exist at this time. However, the installation of high efficiency motors which also improve the power factor has been recommended. See Appendix B (Tab 2) for recommended ECOs.

2. *Decentralize Domestic Hot Water Heaters:* The LSTC building has only one water heater which is used for hand washing only. This is a small commercial electric unit bcated in the basement. Since the hot water demand for this building is very small, the benefits of a point-of-use system retrofit would be small also. In TC-1, there is no water heater or DHW usage at this time. In TC-2, there is a small residential electric point of use unit located above the restrooms, used for hand washing only.

3. *Instantaneous Hot Water Heaters:* As described above, the DHW usage in the buildings studied is very low, and the existing storage type water heaters are relatively small. Therefore, the system losses from the storage tanks and piping systems are minimal, making the benefits of instantaneous water heater installation small.

4. *Replace Or Reactivate Abandoned Boiler in LSTC Building:* The heating requirements of the LSTC building are currently being served by the heat recovery systems on the building chillers. While apparent temperature control problems inside the building make this heating system seem inadequate at times, the actual peak heating load on the building is small. However, the installation of a new, smaller boiler to provide heating is included in another ECO recommending replacement of the existing chillers. See Appendix B (Tab 2) for recommended ECOs.

*ECOs Recommended:* Certain ECOs which were identified during the building survey have been evaluated for technical and economic feasibility and are recommended for implementation. Complete documentation of all calculations as well as information required for implementation is included in Appendix B (Tab 2). These recommended ECOs are summarized in order of descending Savings to Investment Ratio (SIR) in Table 1 on page 8. After reviewing these ECOs with HELSTF personnel and the maintenance contractor for the facility, they have recommended a list of the ECOs summarized in the priority in which they need them. This priority list is shown in Table-2 on Page 9.

*ECOs Not Recommended:* There were no ECOs for which calculations were performed that were rejected or found to be uneconomical. Therefore, there are no non-recommended ECOs in this study.

*Projects Developed:* The energy manager decided to combine the recommended ECOs together for implementation and create three (3) projects. The following projects that resulted from this process will be submitted for funding as ECIP projects. The projects are summarized below in descending order of Savings to Investment Ration (SIR).

Project 1. Lighting Fixture Retrofit, Lighting Control Retrofit, Constant Volume AHU to VAV AHU Retrofit, High Efficiency Motor Retrofit.

Buildings: LSTC, TC-1 and TC-2

| | | |
|---|---|---|
| Electrical Energy Savings: | 5,098 | MMBTU/yr. |
| Diesel Energy Savings: | -56 | MMBTU/yr. |
| Total Energy Savings: | 5,042 | MMBTU/yr. |
| Total Cost Savings: | 126,855 | $/yr. |
| Total Investment: | 439,204 | $ |
| Simple Payback: | 3.46 | yrs. |
| SIR | 4.18 | |

Project 2. Energy Management System Installation

Buildings: LSTC, TC-1 and TC-2

| | | |
|---|---|---|
| Electrical Energy Savings: | 4,419 | MMBTU/yr. |
| Diesel Energy Savings: | 542 | MMBTU/yr. |
| Total Energy Savings: | 4,961 | MMBTU/yr. |
| Total Cost Savings: | 114,087 | $/yr. |
| Total Investment: | 443,021 | $ |
| Simple Payback: | 3.88 | yrs. |
| SIR | 3.72 | |

Project 3. Boiler/Chiller Retrofit

Buildings: LSTC and TC-2

| | | |
|---|---|---|
| Electrical Energy Savings: | 3,297 | MMBTU/yr. |
| Diesel Energy Savings: | 296 | MMBTU/yr. |
| LPG Energy Savings | -906 | MMBTU/yr. |
| Total Energy Savings: | 2,687 | MMBTU/yr. |
| Total Cost Savings: | 78,509 | $/yr. |
| Total Investment: | 694,623 | $ |
| Simple Payback: | 8.85 | yrs. |
| SIR | 1.62 | |

E. Recommended Maintenance & Operations Practices

The following maintenance and operations (M&O) practices are recommended to help conserve energy at HELSTF:

1. Turn off all building interior lighting at night, except forthat required by nighttime security staff.

2. Turn off all computers and electronics equipment while not in use, especially at night and on weekends.

3. Set back space temperature and humidity levels at night and on weekends, or when not required by actual test equipment operation.

4. Request that the lighting maintenance contractor use only energy saving replacement ballasts.

5. Replace lamps on a group basis, at around 80% of rated lamp life, rather than on a spot relamping basis. Create and maintain a relamping log book.

6. Clean light fixtures, lenses and interior reflective surfaces during relamping to maintain light levels.

7. Create and maintain daily log books for chillers and boilers, documenting daily operational patterns such as supply and return water temperatures, compressor amperages, flow rates, hours of operation, etc. Review logs periodically to monitor equipment operational patterns and ensure operating efficiency.

8. Turn off TC-2 air compressor systems whenever possible, especially at night and on weekends.

9. Turn off humidification systems wherever possible. Reevaluate minimum humidity requirements and verify current requirements of these expensive systems with the electronics systems manufacturers.

10. Consult all electronics systems manufacturers to verify current space temperature and humidity requirements. Set back room temperatures at night, weekends, or unoccupied periods wherever possible.

11. Have boiler combustion systems tuned up, clean water side of boilers and measure boiler efficiency, all on an annual basis.

F. Energy and Cost Savings

*Total Potential Energy and Cost Savings:* The energy and cost savings from the implementation of all projects was calculated as follows:

| | | |
|---|---|---|
| Electrical Energy Savings | 12,814 | MMBTU/yr |
| Diesel Energy Savings | 782 | MMBTU/yr |
| Propane Energy Savings | -906 | MMBTU/yr |
| Total Energy Savings | 12,690 | MMBTU/yr |
| Total Cost Savings | 319,546 | $/yr |
| Total Investment | 1,576,848 | $ |
| Simple Payback | 4.9 | yrs |

*Energy Use and Costs Before and After*: Based on the cost and consumption for the base year energy usage as summarized on Page 2, the estimated annual usage for the systems after implementation is as follows:

**Figure 3. Estimated Savings From ECOs**

| Energy Source | Annual Usage | |
|---|---|---|
| | Before | After |
| Electricity | 13,281 MWH | 9,526 MWH |
| Diesel | 124,967 gallons | 119,329 gallons |
| Propane | 51,115 gallons | 59,767 gallons |
| Total Cost | 1,225,535 $/YR | 905,989 $/YR |

*Percentage Saved.* Based on the base year electrical and gas energy consumptions and costs, the percentage of savings from all of the projects is estimated as follows:

$$\textit{Electrical Energy Saved} = \left[\frac{13{,}281 - 9{,}526\ MWH}{13{,}281\ MWH}\right] = 28\%$$

$$\textit{Diesel Energy Savings} = \left[\frac{124{,}967 - 119{,}329\ gallons}{124{,}967\ gallons}\right] = 4.5\%$$

$$\textit{Propane Energy Savings} = \left[\frac{51{,}115 - 59{,}767\ gallons}{51{,}115\ gallons}\right] = -16.9\%$$

$$\textit{Energy Cost Savings} = \left[\frac{1{,}225{,}535\ -\ 905{,}989\ \$}{1{,}225{,}535\ \$}\right] = 26.1\%$$

The only energy source where there would not be a savings is in propane fuel. Because propane is currently not being used by any of the systems we studied, the implementation of the project utilizing a propane boiler will thus increase the propane fuel usage. However, this additional propane fuel increase is more than off-set by the reduction in the electrical energy from the equipment that is currently serving one of the buildings. As a result, the estimated energy cost savings from all of the projects is 26%.

## TABLE 1. ENERGY CONSERVATION OPPORTUNITIES (ECOs) RECOMMENDED

| ECO | Description | Electrical Energy Savings MMBTU/yr | Electrical Demand Savings $/yr | Diesel Energy Savings MMBTU/yr | Propane Energy Savings MMBTU/yr | Total Energy Savings MMBTU/yr | Total Cost Savings $/yr | Total Investment $ | Simple Payback yrs | SIR |
|---|---|---|---|---|---|---|---|---|---|---|
| B | Occupancy Sensors For Lighting Control | 1,454 | 0 | -25 | 0 | 1,429 | 36,117 | 66,787 | 1.9 | 7.8 |
| A | Lighting Fixture Upgrade | 2,016 | 0 | -31 | 0 | 1,985 | 50,103 | 179,176 | 3.6 | 4.1 |
| C | Energy Management System For HVAC Cont | 4,419 | 0 | 542 | 0 | 4,961 | 114,087 | 443,021 | 3.9 | 3.7 |
| D | VAV Controls Retrofit | 1,271 | 0 | 0 | 0 | 1,271 | 31,724 | 140,835 | 4.4 | 3.3 |
| E | High Efficiency Motor Retrofit | 357 | 0 | 0 | 0 | 357 | 8,911 | 52,406 | 5.8 | 2.5 |
| F | Chiller Retrofit At LSTC Building | 2,324 | 0 | 0 | -906 | 1,418 | 52,154 | 415,174 | 7.8 | 2.0 |
| H | Boiler Retrofit At Test Cell 2 Building | 69 | 0 | 296 | 0 | 365 | 3,791 | 30,559 | 8.1 | 1.7 |
| G | Chiller Retrofit At Test Cell 2 Building | 904 | 0 | 0 | 0 | 904 | 22,564 | 248,890 | 9.7 | 1.6 |
| | Totals | 12,814 | 0 | 782 | -906 | 12,690 | 319,451 | 1,576,848 | 4.9 | |

## TABLE 2. HELSTF ECO PRIORITY LIST

| ECO | Description | Electrical Energy Savings MMBTU/yr | Electrical Demand Savings $/yr | Diesel Energy Savings MMBTU/yr | Propane Energy Savings MMBTU/yr | Total Energy Savings MMBTU/yr | Total Cost Savings $/yr | Total Investment $ | Simple Payback yrs | SIR |
|---|---|---|---|---|---|---|---|---|---|---|
| F | Chiller Retrofit At LSTC Building | 2,324 | 0 | 0 | -906 | 1,418 | 52,154 | 415,174 | 7.8 | 2.0 |
| G | Chiller Retrofit At Test Cell 2 Building | 904 | 0 | 0 | 0 | 904 | 22,564 | 248,890 | 9.7 | 1.6 |
| H | Boiler Retrofit At Test Cell 2 Building | 69 | 0 | 296 | 0 | 365 | 3,791 | 30,559 | 8.1 | 1.7 |
| C | Energy Management System For HVAC Cont | 4,419 | 0 | 542 | 0 | 4,961 | 114,087 | 443,021 | 3.9 | 3.7 |
| D | VAV Controls Retrofit | 1,271 | 0 | 0 | 0 | 1,271 | 31,724 | 140,835 | 4.4 | 3.3 |
| A | Lighting Fixture Upgrade | 2,016 | 0 | -31 | 0 | 1,985 | 50,103 | 179,176 | 3.6 | 4.1 |
| B | Occupancy Sensors For Lighting Control | 1,454 | 0 | -25 | 0 | 1,429 | 36,117 | 66,787 | 1.9 | 7.8 |
| E | High Efficiency Motor Retrofit | 357 | 0 | 0 | 0 | 357 | 8,911 | 52,406 | 5.8 | 2.5 |
| | Totals | 12,814 | 0 | 782 | -906 | 12,690 | 319,451 | 1,576,848 | 4.9 | |


LSTC Building


Test Cell 1
Test Cell 2

## II. NARRATIVE REPORT

8/23/96

### A. Entry Interview

*Work Plan:* An entry interview meeting was conducted at HELSTF on October 10, 1995. Present at the meeting were representatives of Huitt Zollars Inc. (HZ), C.A. Pieper, P.E., *Project Manager*, and Denney Howard, P.E., *Electrical Engineer*, as well as representatives from HELSTF, Bob Anderson, *Facility Engineer* and others. At that time, a description of the work plan for this study was presented. The work plan was a summary of the individual tasks to be performed to complete the energy study and the approximate date that each task was to begin. Each step of the work plan was described in detail to HELSTF personnel and adjusted to the plan as shown in Figure 4.

**Figure 4. Work Plan**

| | |
|---|---|
| 10/9/95 | Entry Interview |
| 10/9/95 | Building & Systems Data Collection |
| 10/16/95 | Formulate ECOs & Perform Calculations |
| 1/16/96 | Interim Findings Submittal |
| 5/6/96 | Pre-Final Report Submittal |
| 7/1/96 | Final Report Submittal |

*Data List:* After discussing the work plan, HELSTF was presented with a list of data items to be collected by the study team, shown in Figure 5. This list was a summary of the information required by the surveyors. The study team and HELSTF personnel discussed the methods by which all of the data on the list were to be obtained. HELSTF personnel provided direction as to where to obtain information on the list. They also provided useful information on past energy conservation efforts, as well as any ongoing or future planned energy conservation measures. The data concerning the existing building, lighting and HVAC systems were to be collected from the walk-through and recorded onto preprinted data forms. Building mechanical and electrical drawings were to be collected, information extracted and included on individual building data forms. All data forms are included in Appendix F (Volume II, Tab 6).

**Figure 5. Data Acquisition List**

1. Existing lighting systems and controls.
2. Building HVAC system types and operational schedules. (Amp motors)
3. Building size, age and remaining useful life.
4. Existing building operational schedules and area usage.
5. Facility electricity, gas, other utility rates and 12 monthbilling histories.
6. Utility company rebate programs.
7. Past and proposed energy conservation projects.
8. Typical maintenance and retrofit procedures and costs.
9. Building environmental control requirements.
10. HVAC control systems and capabilities.
11. Miscellaneous building equipment and operational schedules.
12. Building envelope descriptions.
13. Domestic hot water requirements and systems.
14. Building internal cooling loads.

*ECO List:* Following the discussion on the data list, HELSTF personnel were presented with a list of suggested Energy Conservation Opportunities (ECOs) that were identified for evaluation in the Detailed Scope of Work. This list is shown on page D-13 (Tab 4). It was explained to HELSTF

personnel that all of these suggested ECOs were to be evaluated, as well as any others that they might suggest, or any identified by the HZ staff during the site visit. After discussing the potential ECOs which might exist at the facility, the meeting was adjourned and the HZ staff began the collection of data.

B. Data Collection.

Following the entry interview, the study team began the task of collecting the required data. First, building mechanical and electrical drawings were studied and data was extracted. Then field surveys were made on all of the buildings in the study to verify and supplement data collected from the drawings. All of the data obtained from drawings and field surveys were put onto data sheets and included in Appendix F (Volume II, Tab 6). The following summarizes the data collection phase of this study.

*Building Data:* This study was performed on three buildings, the Laser Systems Test Center (LSTC), Test Cell 1 (TC-1) and Test Cell 2 (TC-2). Building description data sheets and basic floor plans are included in Appendix F (Volume II, Tab 6). The three buildings are generally described as follows:

1. LSTC - This four story, mostly underground, building was constructed in 1963, but was remodeled in 1982 for its current use as a laser systems test control center. The upper two floors are all that is above ground, and are covered in three domed structures. The building has a gross floor area of 89,400 sqft and houses all of HELSTF administrative and contractor offices, as well test monitoring and control centers. The building is generally occupied Monday through Friday, between 7:00 a.m. and 5:00 p.m.

2. TC-1 - This four story building was constructed in 1982 for use as a laser system testing facility. The building has a gross floor area of 19,329 sqft and houses experimental laser systems and electronic data gathering equipment. The building is lightly occupied by scientists and technicians Monday through Friday, between 7:00 a.m. and 5:00 p.m. However, when testing is conducted periodically (on the average of once or twice a month), the building is more heavily occupied.

3. TC-2 - This two story building was constructed in 1982 to serve as a central thermal energy plant for the test cell area. The building has a gross floor area of 5,133 sqft and houses the central chiller and boiler systems, compressed air systems and distilled water systems for the test cell area. The building is generally unoccupied most of the time, except for equipment operation or maintenance.

*HVAC Systems Data:* Equipment data sheets, containing detailed information of the quantities and types of mechanical equipment in the three buildings, are contained in Appendix F (Volume II, Tab 6). General descriptions of the mechanical systems are as follows:

1. LSTC - The primary cooling system consists of a pair of 175 ton, centrifugal, water cooled chillers which are 13 years old and use R-11 refrigerant. These chillers are piped in series and have heat reclaim water heaters installed on the condenser barrels. These machines are located in the building's basement and generally produce 42°F to 45°F chilled water (CHW) for the numerous air handler cooling coils. A two cell packaged cooling tower serves the chillers. The cooling tower has very recently been retrofitted, and is in excellent condition. The chillers, on the other hand, are maintenance intensive and have caused problems with

facility operations when both chillers are off-line for maintenance purposes. Moreover, both of these chillers require R-11 refrigerant which is no longer produced as of January 1, 1996. Even though the refrigerant will be available for service in the near future, the price of the refrigerant will continue to increase as the refrigerant becomes more scarce. Therefore, these two chillers need to be replaced, and according to the HELSTF and maintenance contractor, need to be replaced as soon as possible. However, after implementing the ECOs preceding the chiller retrofit, it was determined that the second chiller would operate only a small percentage of the year. Therefore, it would be uneconomical to modify or replace more than one chiller under the limitations and scope of this study. Therefore, the owner needs to address and consider replacing both chillers using all other means possible.

The primary heating system consists of the two heat reclaim water heaters installed on the chillers as mentioned previously. These water heaters produce approximately 95°F heating water for circulation through the building's numerous duct-mounted heating coils. The building was originally equipped with a large scotch marine type steam boiler for heating. But this boiler has not been operated since the heat reclaim systems were installed. Because the building is mostly underground, the heating load is generally small. Most of the heating requirements are for reheating of supply air for space temperature control.

Two CHW pumps and one HW pump are located within the basement near the water chillers. These primary pumps distribute thermal energy to the coils through a four-pipe distribution loop. Two vertical turbine condenser water pumps are located outside next to the cooling tower and circulate condenser water (CND) between the chillers and the tower. The distribution piping systems were reported to be in generally good condition. The domestic hot water (DHW) for the building is generated by a single, electric water heater in the basement. The only use for DHW in the building is in the restrooms.

Secondary HVAC systems in the building consist of multiple single zone and multizone air handling units (AHUs) in the basement. These units were installed in the original 1963 construction and were refitted and recommissioned during the 1982 building remodel. The various test control centers and computer rooms all had supplemental cooling provided by Liebert-type computer room units, supplying cooling air through the 12" raised floor in those areas. These units were installed in the 1982 remodel. Overall HVAC system performance in the building is average, but temperature control and air side capacity appear to be a problem. The problem with temperature control is partially due to the small number of thermostats controlling large areas of the building. Measurements taken during the site visit showed a building temperature variation of 67°F in some areas up to 74°F in other areas. The 1982 HVAC systems design was supposed to maintain a 70°F ambient temperature, with a plus or minus 2°F tolerance, and 45% relative humidity (RH), with a plus or minus 5% tolerance. This was to be accomplished with constant volume reheat systems. The original HVAC systems design conditions, combined with the building's air system configurations, make the HVAC energy consumption excessive. Moreover, current electronics systems typically require less stringent environmental control than was required 13 years ago. Therefore, there may no longer be a need for the original HVAC system design tolerances which contribute to excessive energy consumption. The lack of capacity on the air side systems is beyond the limitations and scope of this study. However, a more detailed analysis of the air side systems should be recommended to determine the areas affected and the magnitude of the effect.

Pump and fan motors used in the building are generally standard efficiency motors. The replacement of these motors with premium efficiency motors could help save electrical energy.

2. TC-1 - The building itself has no primary heating and cooling systems, and is served by the central thermal energy plant in building TC-2. There is also no DHW system or usage in this building.

The secondary HVAC system in this building consists of multiple, four-pipe, single zone air handlers, located within the mechanical room and on the second floor rooftop. As mentioned earlier, this building houses the critical testing and optics equipment that has historically required stringent temperature, humidity, and pressure requirements. For example in 1982, the HVAC systems were redesigned to maintain optical paths throughout the building. The design not only included temperature and humidity control but also the control for maintaining a 5% positive pressure relationship. Single zone air handling units were designed with duct mounted reheat coils. The supply air temperature is controlled at a constant temperature an average of 52°F. Thus, there are many days that the air is sub-cooled below what is needed and then reheated to maintain the space temperature. Although there may not be a need to set the supply air temperature to a constant value, there is still a need to maintain the supply airflow and the pressure requirement. Thus, the recommendations in this study will only look at ways that will reduce the energy consumption without changing the pressure relationship in the space or airflow patterns. Overall, the HVAC system performance in this building is good, but inefficient.

Pump and fan motors used in the building are generally standard efficiency motors. The replacement of these motors with premium efficiency motors could help save electrical energy.

3. TC-2 - The building contains the central CHW and HW plants for the buildings in the test cell area. The primary cooling system consists of a pair of 175 ton centrifugal, water cooled chillers, which are 13 years old and use R-11 refrigerant. One chiller was provided as a standby unit only, and is generally not required to meet peak cooling loads. These machines are located on the first floor and generally produce 42°F to 45°F CHW for the test cell area's air handler cooling coils. A two cell packaged cooling tower is located outside to serve the chillers. The cooling tower has very recently been retrofitted, and is in excellent condition. The chillers, on the other hand, have recently required maintenance, and one has even had the compressor replaced. Moreover, both of these chillers require R-11 refrigerant which is no longer produced as of January 1, 1996. Even though the refrigerant will be available for service in the near future, the price of the refrigerant will continue to increase as the refrigerant becomes more scarce. Therefore, these two chillers need to be replaced, and according to the HELSTF and maintenance contractor, need to be replaced as soon as possible. However, since one machine currently operates as a standby unit, it would be uneconomical to modify or replace more than one chiller under the limitations and scope of this study. Therefore, the owner needs to address and consider replacing both chillers using all other means possible.

The primary heating systems consist of a pair of oil fired firebox boilers which are 13 years old and have a combined rated capacity of 2208 MBH. Again, one boiler was provided as a standby unit only, and is generally not required to meet peak heating loads. The boilers

are located on the second floor of the building and generally produce 220°F HW. These boilers appeared to be in poor condition, and were reported to contain asbestos lining on the inside, preventing thorough cleaning. More efficient boilers, which could be more readily maintained, are currently available. However, since one boiler is a standby unit, it would be uneconomical to replace more than one boiler. One shell and tube heat exchanger was located adjacent to the boilers. The HW from the boilers is circulated through the heat exchanger, to produce 180°F HW for distribution through the air handling systems in the test cell area. These heat exchangers should be eliminated from the systems, and HW from the boilers circulated directly to improve the overall heating system efficiency.

A pair of CHW pumps are located near the chillers on the first floor to distribute CHW to the cooling coils in the test cell area. Four HW pumps are located near the boilers on the second floor. Two of these HW pumps circulate water between the boilers and the heat exchangers, and the other two circulate HW between the heat exchangers and the heating coils. DHW for the restroom in TC-2 is generated by a small, residential type electric water heater.

The only secondary HVAC system in TC-2 is a residential type evaporative cooling unit located on the second floor of the building. This unit is operated in the summertime to reduce the second floor space temperatures where the boilers are located.

Pump and fan motors used in the building are generally standard efficiency motors. The replacement of these motors with premium efficiency motors could help save electrical energy.

*Lighting Data:* Lighting equipment data sheets with actual measured lighting levels are included in Appendix F (Volume II, Tab 6). The lighting system in the three buildings is generally described as follows:

1. <u>LSTC</u> - Interior lighting in the building is generally fluorescent in most areas. These lay-in and surface mounted fixtures are generally equipped with standard magnetic ballasts and F40CW/T12 lamps. The installation of electronic ballasts and T-8 lamps throughout the building could help save lighting energy. Also, installed in many areas are some high wattage incandescent lamp holders. This is an inefficient light source with a short lamp life, and should be retrofitted with compact fluorescent lamps. The lighting measurements, taken during the site visit and the COE recommended design values for each area, are listed on the lighting equipment lists. Measured lighting levels were generally higher than the COE recommended levels. The replacement of fluorescent lamps should maintain the lighting levels at their present levels with a decrease in energy consumption since the replacement energy efficient lamps have an equivalent or higher lumen output and a lower wattage than the existing standard efficiency lamps. There are no switches in many areas and therefore hallway and other area lighting remains on most of the time. Only some office lighting is turned off by the occupants when leaving the building. Automatic controls, such as occupancy sensors, should be installed to turn off lights in some areas, such as offices, equipment rooms, janitor closets, storage rooms, restrooms, and break areas, during unoccupied times. The exit signs, in the building, utilize incandescent lamps. The installation of LED retrofit kits throughout the building could help save lighting energy. Because of the domed above ground exterior of the building, there is no exterior lighting.

2. TC-1 - Interior lighting in the building is generally high pressure sodium and fluorescent in all areas. The fluorescent lighting is generally equipped with standard magnetic ballasts and F40CW/T12 lamps. The installation of electronic ballasts and T-8 lamps throughout the building could help save lighting energy. Also, installed in many areas are some high wattage incandescent lamp holders. This is an inefficient light source with a short lamp life, and should be retrofitted with compact fluorescent lamps. The lighting measurements, taken during the site visit and the COE recommended design values for each area, are listed on the lighting equipment lists. Measured lighting levels were generally higher than the COE recommended levels. The replacement of fluorescent lamps should maintain the lighting levels at their present levels with a decrease in energy consumption since the replacement energy efficient lamps have an equivalent or higher lumen output and a lower wattage than the existing standard efficiency lamps. There are few switches in many areas and therefore much of the lighting remains on most of the time. Only some of the lighting is turned off by the occupants when leaving the building. Automatic controls, such as occupancy sensors, should be installed to turn off lights in some areas, such as control rooms, equipment rooms, storage rooms, and vestibules, during unoccupied times. The exit signs, in the building, utilize incandescent lamps. The installation of LED retrofit kits throughout the building could help save lighting energy. Exterior lighting consists of high pressure sodium wall packs mounted on the building around the perimeter. This is an efficient lightsource and should remain in use.

3. TC-2 - Since the evaluation of the lighting systems of Test Cell 2 were not included in the scope of this study, only visual observations were made at the time of the site visit. No lighting ECOs were calculated for this building, but observations and recommendations are included herein. Interior lighting in the building is generally high pressure sodium and fluorescent in all areas. The fluorescent strip lighting is generally equipped with standard magnetic ballasts and F40CW/T12 lamps. The installation of electronic ballasts and T-8 lamps throughout the building could help save lighting energy. Also, installed in many areas are some high wattage incandescent lamp holders. This is an inefficient lightsource with a short lamp life, and should be retrofitted with compact fluorescent lamps. The exit signs, in the building, utilize incandescent lamps. Exterior lighting consists of high pressure sodium wall packs mounted on the building around the perimeter. This is an efficient light source and should remain in use.

*Maintenance and Operations Data:* All lighting and HVAC system maintenance at the facility is performed by an outside contractor, Aerotherm Inc. In general, facility maintenance appears to be adequate, with most systems functioning properly during the site visit. The maintenance personnel were very knowledgeable about the building systems, and took pride in their proper operation. Lighting maintenance appeared to be somewhat less than desirable however, with many lights remaining burned out for long periods.

Most systems in the buildings studied are generally operated 24 hours a day, 365 days a year. This includes lighting, HVAC systems and test monitoring and control electronics systems. Also, the HVAC systems work to maintain constant space temperatures and humidity levels 24 hours a day, with no setback times. Actual testing of laser systems happen only periodically, approximately every other month for several hours. Therefore it seems that there is ample opportunity to shut down equipment during times of little occupancy or need and to set back temperature and humidity ranges within the buildings in an effort to reduce overall energy consumption and cost.

Actual measurements taken during the walk-through determined that the electrical demand of all electronics equipment in the LSTC building was 50 KW and in the TC-1 building was 22 KW. These measurements were taken from the Uninterruptible Power Supply (UPS) systems which serve the buildings. All laser system test-related electronics equipment was said to be fed through these UPS systems. It was also determined that the equipment in operation during the time of these measurements was left on 24 hours a day, year round. Although this was estimated to be about 50% of the total building electronics equipment load, used during the infrequent testing, it is still a major source of energy usage at the facility, and impacts the building cooling systems as well. A serious effort to identify nonessential equipment that can be turned off, especially at night and on weekends, should be made in the LSTC and TC-1 buildings. This could potentially save thousands of dollars a year at little or no cost to the facility.

Also, at the TC-2 building, the compressed air systems are in operation 24 hours a day, year round. Just as with the electronics equipment mentioned previously, an effort should be made to turn this equipment off at night and on the weekends. As the compressed air systems are used for test-related equipment in the test cell area, a study by the facility staff would be required to identify periods when they could be safely turned off.

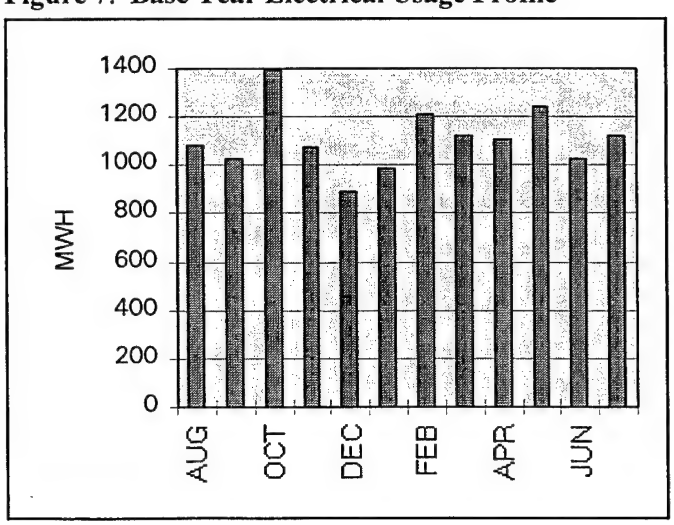
**Figure 6. Base Year Utility Data**

| Billing Period | Electrical | | Diesel | | Propane | |
|---|---|---|---|---|---|---|
| | Usage MWH | Cost $ | Usage Gallons | Cost $ | Usage Gallons | Cost $ |
| AUG | 1,078 | 88,484 | 11,500 | 11,155 | 410.2 | 285 |
| SEP | 1,023 | 84,010 | 11,833 | 11,478 | 5290.5 | 3,672 |
| OCT | 1,390 | 105,244 | 15,074 | 14,622 | 4376.0 | 3,037 |
| NOV | 1,076 | 81,457 | 16,860 | 16,354 | 8705.8 | 6,042 |
| DEC | 893 | 67,594 | 13,055 | 12,663 | 17714.2 | 12,294 |
| JAN | 986 | 80,978 | 16,500 | 16,005 | 3405.8 | 2,364 |
| FEB | 1,211 | 99,435 | 6,062 | 5,880 | 7036.9 | 4,884 |
| MAR | 1,125 | 92,340 | 5,000 | 4,850 | 2150.3 | 1,492 |
| APR | 1,109 | 91,052 | 6,083 | 5,901 | | |
| MAY | 1,241 | 101,851 | 5,000 | 4,850 | | |
| JUN | 1,029 | 84,478 | 13,000 | 12,610 | | |
| JUL | 1,120 | 91,919 | 5,000 | 4,850 | 2025.0 | 1,405 |
| Total | 13,281 | 1,068,842 | 124,967 | 121,218 | 51114.7 | 35,475 |

*Utility Data:* A recent 12-month utility billing history was obtained from the facility staff and is shown in Figure 6. This data can be used as a benchmark to compare the computer simulations output for the facility. Moreover, this 'base year' history included an estimation of the electric consumption for the site, as well as all delivered liquid propane and diesel fuel (heating usage only) during the period of October 1994 through September 1995. The facility does have an electrical meter serving the LSTC building and that is assumed by the base to be 80% of the total consumption for HELSTF. The electric service is provided by the El Paso Electric Company (EPEC), and the liquid propane and diesel fuel are provided by local suppliers. All of these utilities are currently billed to HELSTF through the U.S. Army at the White Sands Missile Range. The total cost of electricity for the base year was $1.07 million and the total cost for liquid propane and diesel fuel was $157 thousand.

A graph of the base year electrical energy usage is shown in Figure 7. Looking at the graph, the consumption

**Figure 7. Base Year Electrical Usage Profile**



does not follow a typical curve for a facility that utilizes alternative heatingfuel. There are a couple of reasons for this. One is that the testing schedule for HELSTF is sporadic and the testing process consumes a significant amount of energy. Furthermore, during the "Base Year", not only did the main transformer explode, but the base also lost the capabilities of one of the central meters. Therefore, both the EPEC and White Sands Missile Range decided to estimate the consumption during this time on historical data.

A graph of the base year diesel fuel usage is shown in Figure 8. This profile is very unusual, but perhaps reflects that diesel fuel is used for space and process heating or reflects the other users besides HELSTF. The variation of monthly fuel deliveries indicates that heavy process heating was required from August through January, and again in June. The fuel deliveries in the other months, while approximately half as much as before, are still excessive. This is possibly an indication of inefficiencies in the diesel fired heating systems, as well as continuous operation of this equipment. In either case, it seems to indicate that the potential for diesel fuel savings is significant at HELSTF.

**Figure 8. Base Year Diesel Usage Profile**

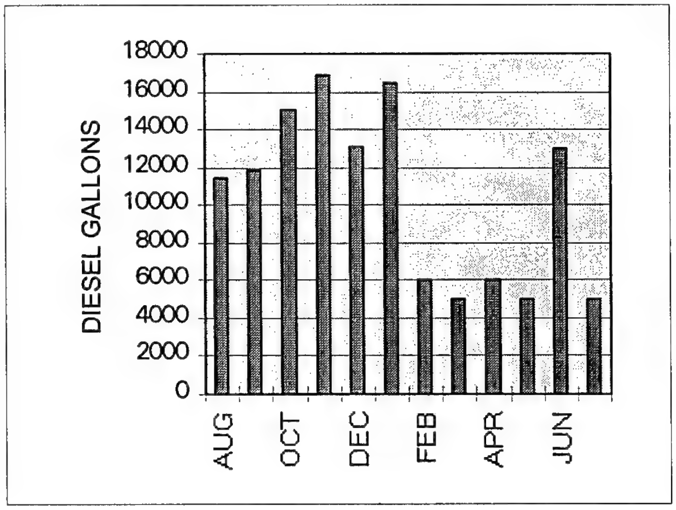
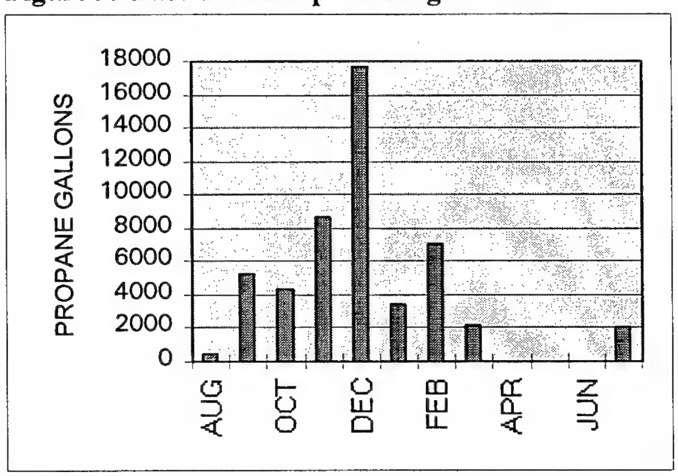



**Figure 9. Base Year Propane Usage Profile**




A graph of the base year liquid propane usage is shown in Figure 10. This profile is more typical for a heating fuel, with an annual 'heating hump' during the winter season, and minimal or no usage the rest of the year. In the buildings included in this study, there is currently no propane usage. However, this study will recommend using propane fired boilers if applicable.

The current electric utility rates from EPEC, as well as the current costs of propane and diesel, were obtained during the audit and are included in the Appendix A. The current avoided cost for electrical savings is $0.083 per KWH. For diesel fuel savings the avoided cost is $0.97 per gallon, and for liquid propane savings the avoided cost is $0.676 per gallon.

*Replacement Boiler Selection*: Data on available replacement boilers were obtained from typical manufacturers in order to select representative boilers for ECO evaluations. This data included performance characteristics, physical dimensions and cost figures. The criteria for selecting new boiler systems for the ECOs are described below.

1. Efficiency. Replacement boilers that had the highest overall efficiency over the operating range were selected in each area. In most cases, this criteria was met by the high-efficiency modular boilers which were modeled in the ECOs. These are fully condensing, forced draft firetube units that have efficiencies to 99 % in part load operation. No other boilertype was found to match this performance.

2. Turn-down ratio. In order to limit the thermal shock and efficiency losses associated with cycling, replacement boilers for the ECOs needed to have a high turn-down ratio. The 14:1 ratio associated with the modular boilers used in most ECOs wasas good or better than other available boilers with lower efficiencies. And the modular concept of using multiple boilers to match the heating loads, combined with this high turn-down ratio, minimizes the negative impacts of cycling.

3. Controls. In order to closely match the heating load requirements at any given time,all new boilers were selected with fully modulating controls. Two-position or multi-stage controls would increase the possibility of boiler cycling, as well as reduce the part load efficiency.

4. Physical size. In order to fit the new boilers into the buildings without modifying the existing boiler room openings, the small footprint and overall size of the modular boilers was the best choice for the ECOs. Other types of boilers were larger and would require more effort and cost to install in the buildings.

5. First cost. The first cost of the modular boilers was greater than other types available. However, the efficiency improvements of these units justified the higher initial first costs in the Life Cycle Cost Analysis.

6. Maintenance requirements and costs. All types of replacement boilers would require annual cleaning of the heat exchanger surfaces, as well as blow-down and optimization of the combustion systems. The boilers used in the ECOs appeared to be as good or better than all other boiler types in ease of maintenance. This is due to their small physical size and construction features.

*Replacement Chiller Selection*: Data on available replacement chillers were obtained from typical manufacturers in order to select representative chillers for ECO evaluations. This data included performance characteristics, physical dimensions and cost figures. The criteria for selecting new chiller systems for the ECOs are described below.

1. Machine Type. Water cooled machines were selected over air cooled machines because existing cooling towers, pumps, etc. could be used with the proposed chillers. Additionally, the efficiencies of the water cooled equipment is higher than the air cooled equipment of this size. Generally, in the 100-200 ton range, the three types available are screw, centrifugal, and reciprocating. Reciprocating was selected as a third choice because the efficiency of the machines is very low. Centrifugal and screw machines were compared with each other based on efficiency and first cost.

3. Drive configuration. The new machines selected for ECO analysis all had open drives on the compressors. This increases the first cost somewhat, but decreases the long term maintenance costs.

4. Refrigerant. Replacement chillers were to all use either R-22, R-123 or R-134a refrigerant, as per the scope of work, and the size of the chiller.

5. Efficiency. The full and part load efficiencies for all machines selected for evaluation were used in the ECOs. The relative effects of these efficiency differences are illustrated in the Life Cycle Cost Analysis of each machine.

6. First cost. The first cost data for all machines selected for evaluation were used in the ECOs. The relative effects of these cost differences are illustrated in the Life Cycle Cost Analysis of each machine.

7. Maintenance requirements and costs. All types of replacement chillers would require periodic cleaning of the heat exchanger surfaces, as well as optimization of the compressor systems and controls.

C. Plan To Implement Projects:

*Project Funding:* The DD-1391 forms, the associated cost estimates and life cycle cost analysis summary sheets for all projects are provided on pages 22 through 53. These are to be submitted for project funding, along with the calculations in Appendix B, if required.

*Programming:* An engineering design firm should be selected to produce construction contract drawings and specifications for all of the projects which are funded either through ECIP or by other means. All of the savings calculations and cost estimates for the recommended ECOs in Appendix B should be supplied to the designers in order to inform them of the intent and projected budget of each ECO. The designers should use the equipment sizing described in the ECOs as a guide only, and perform all calculations necessary to properly size all new equipment These calculations should take into consideration all existing field conditions in the areas effected by the ECOs. It is recommended that existing auxiliary equipment be reused wherever possible to reduce the first cost of each project. The designer should field verify the condition of all existing equipment before specifying it's disposition. Where equipment is to be removed, the specifications should include some provisions dealing with the possible salvage value of this equipment. The facility's project manager should ensure that all new designs produced by the design firm do conform with the intent of each ECO, in order to realize the estimated savings. All construction drawings and specifications should be compared to the original ECOs to ensure compliance, prior to releasing for bids.

*Construction*: Once the plans and specifications have been reviewed and approved, the facility's project manager should release them for bids, using their normal construction procurement proceedings. Care should be taken to schedule all work at a time which would minimize the negative impact of projects on the buildings that remain occupied and during testing periods. Prior to construction, the facility should review all shop drawings and submittals to once again ensure compliance with the original intent of each ECO.

| 1. COMPONENT ARMY | FY 1997 MILITARY CONSTRUCTION PROJECT DATA | 2. DATE 8/23/96 |
|---|---|---|

| 3. INSTALLATION AND LOCATION | 4. PROJECT TITLE |
|---|---|
| HELSTF, WHITE SANDS MISSILE RANGE, NM. | ECIP - Lighting/HVAC Retrofit, Project 1 |

| 5. PROGRAM ELEMENT | 6. CATAGORY CODE | 7. PROJECT NUMBER | 8. PROJECT COST ($000) |
|---|---|---|---|
| | | | 439.204 |

9. COST ESTIMATES

| ITEM | U/M | QUANTITY | UNIT COST | COST ($000) |
|---|---|---|---|---|
| LIGHTING FIXTURE UPGRADE | EA | 1 | 179.2 | 179.2 |
| OCCUPANCY SENSORS FOR LIGHTING CONTROL | EA | 1 | 66.8 | 66.8 |
| VAV RETROFIT | EA | 1 | 140.8 | 140.8 |
| HIGH EFFICIENCY MOTOR RETROFIT | EA | 1 | 52.4 | 52.4 |
| ESTIMATED CONTRACT COST | | | | 398.895 |
| CONTINGENCY (0%) | | | | 0.0 |
| SIOH | | | | 19.865 |
| DESIGN | | | | 20.444 |
| TOTAL REQUEST | | | | 439.204 |
| TOTAL REQUEST (ROUNDED) | | | | 439.000 |

10. DESCRIPTION OF PROPOSED CONSTRUCTION

A: Retrofit 1,796 existing fluorescent light fixtures with electronic ballasts and T8 lamps. This will require a total of 1,796 ballasts and 3,533 lamps. Replace 37 incandescent lamps in existing fixtures with compact fluorescent lamps. This will require an electronic ballast adapter base which screws into the existing fixture base. Replace all incandescent lamps in the 37 exit signs with LED light strips.

B. Install 201 ceiling mounted motion sensors in various area of the LSTC and TC-1 buildings. Re-circuit the area light fixtures to the occupancy sensors to turn off the lights during unoccupied periods.

C. Convert 7 existing single zone or multizone , constant volume air handling units in the LSTC building to VAV. Install variable frequency drive and static pressure controller for each air handling unit. Install 112 VAV retrofit air valves with pneumatic controls to maintain space temperature conditions.

D. Replace 47 existing fan and pump motors in the LSTC, TC-1 and TC-2 buildings with high efficiency motors. Motors serving backup systems will not be replaced, due to the reduced run times of these motors.

| 1. COMPONENT ARMY | FY 1997 MILITARY CONSTRUCTION PROJECT DATA | 2. DATE 8/23/96 |
|---|---|---|

3. INSTALLATION AND LOCATION
HELSTF, WHITE SANDS MISSILE RANGE, NM.

| 4. PROJECT TITLE | 5. PROJECT NUMBER |
|---|---|
| ECIP - Lighting/HVAC Retrofit, Project 1 | |

11. REQUIREMENT

The project is required to reduce lighting and HVAC systems energy consumption at HELSTF. The project provide more energy efficient lighting systems, fan and pump motors, and air handling systems. All buildings included in this project will be active throughout the payback period. Installation of these retrofits will result in the following:

| | | |
|---|---|---|
| Electrical Energy Savings | 5,098 | MMBTU/yr |
| Diesel Energy Savings | -56 | MMBTU/yr |
| Total Energy Savings | 5,042 | MMBTU/yr |
| Total Cost Savings | 126,855 | $/yr |
| Total Investment | 439,204 | $ |
| Simple Payback | 3.46 | yrs |
| SIR | 4.18 | |

CURRENT SITUATION:

A. The existing 4 foot fluorescent fixtures in the LSTC and TC-1 buildings currently use standard T12, 40 watt lamps and magnetic ballasts. The retrofit will replace the existing lamps and ballasts with T8 lamps and electronic ballasts. The existing incandescent light fixtures in the LSTC and TC-1 buildings currently use standard 100, 150 and 200 watt incandescent lamps. The retrofit will replace the existing lamps with compact fluorescent lamps. The existing exit lights in the LSTC and T-1 buildings use two 20 watt incandescent lamps. The retrofit will replace the existing lamps with two 2 watt LED light strips. Each of these lighting retrofits will produce an equivalent or higher lumen output per fixture, with a significantly lower power input. Since this retrofit will reduce the building lighting load, there will be savings in HVAC cooling energy, and a penalty in heating energy.

B. Several areas in the LSTC and TC-1 buildings are unoccupied for a large portion of the work day. The areas typically have 4 foot fluorescent lighting fixtures, which is left on during these unoccupied periods. Typical areas considered for this ECO are mechanical/electrical rooms, storage rooms, restrooms, offices, conference rooms, computer centers and other miscellaneous areas. Ceiling mounted motion sensors will be installed to turn off the lighting in these areas when the areas are unoccupied. Since the retrofit will reduce the building lighting load, there will be savings in HVAC cooling energy and a penalty in heating energy.

C. Air handling units 1, 2, and 7 are multizone type AHU. The space temperature of these units is maintained by varying the supply air temperature while maintaining constant airflow. AHUs 3, 5, 6, and S-4 are single zone constant volume unit with hot water reheat. Space temperature setpoints are maintained by reheating cold primary air. The current control strategies and operation of these units waste thermal energy. These AHU will be converted to variable volume units, with the addition of variable frequency drives, VAV retrofit air valves with pneumatic controls and duct static pressure controllers to minimize the energy required to satisfy the space conditions.

D. The existing fan and pump in the LSTC and TC-1 buildings utilize standard efficiency motors. The retrofit will replace the existing motors with high efficiency motors that will provide an equivalent horsepower output with a lower power input.

IMPACT IF NOT PROVIDED

If this project is not provided, the above mentioned savings in lighting and cooling energy and costs will continue to be wasted. There will be no contribution to the energy reduction goals established at the facility.

Life Cycle Cost Analysis                                    Study: HELSTF.LC
Energy Conservation Investment Program (ECIP)                LCCID FY96
Installation & Location: WSMR
Region data: NEW MEXICO     Census Region: 4
Project NO. & Title: 03-0185.05 EEAP ENERGY STUDY - HELSTF FACILITY
cal Year: 1997 Discrete Portion: PROJECT 1
lysis Date: 08/20/96 Economic Life: 20 years
Prepared by: Michael W. Elliott, P.E., CEM

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | 398895 |
| B. SIOH | 19865 |
| C. Design Cost | 20444 |
| D. Total Cost (1A+1B+1C) | $439,204 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $439,204 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1995

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $25. | /Mbtus | 5,098 | Mbtus | $127,246 | 14.47 | $1,841,251 |
| Elec. Deman | | | | | $0 | 13.47 | $0 |
| Distillate | $. | /Mbtus | 0 | Mbtus | $0 | 17.01 | $0 |
| esidual Oi | $. | /Mbtus | 0 | Mbtus | $0 | 17.23 | $0 |
| tural Gas | $. | /Mbtus | 0 | Mbtus | $0 | 17.32 | $0 |
| al | $. | /Mbtus | 0 | Mbtus | $0 | 14.04 | $0 |
| LPG | $6.5 | /Mbtus | 0 | Mbtus | $0 | 15.64 | $0 |
| Solar | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Geothermal | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Biomass | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Refuse | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Wind | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Other | $7. | /Mbtus | -56 | Mbtus | -$391 | 13.47 | -$5,273 |
| TOTAL | | | 5,042 | Mbtus | $126,855 | | $1,835,978 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

| | |
|---|---|
| 4. First Year Dollar Savings | $126,855 |
| 5. Simple Payback Period (Years) | 3.46 |
| 6. Total Net Discounted Savings | $1,835,978 |
| 7. Savings to Investment Ratio | 4.18 |
| f < 1, Project does not qualify | |
| djusted Internal Rate of Return | 11.82% |

Life Cycle Cost Analysis Study: HELSTF.LC

Energy Conservation Investment Program (ECIP) LCCID FY96

Installation & Location: WSMR

Region data: NEW Census Region: 4

Project NO. & Title: 03-0185.05 EEAP ENERGY STUDY - HELSTF FACILITY

Fiscal Year: 1997 Discrete Portion: ECO-A

Analysis Date: 08/16/96 Economic Life: 20 years

Prepared by: MICHAEL W. ELLIOTT, P.E., CEM

ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $162,718 |
| B. SIOH | $8,111 |
| C. Design Cost | $8,347 |
| D. Total Cost (1A+1B+1C) | $179,176 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $179,176 |

2. Energy Savings (+) / Costs (-)

Date of NISTIR 85-3273-X used for Discount Factors Oct 1995

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $25. | /Mbtus | 2,016 | Mbtus | $50,319 | 14.47 | $728,121 |
| Elec. Deman | | | | | $0 | 13.47 | $0 |
| Distillate | $. | /Mbtus | 0 | Mbtus | $0 | 17.01 | $0 |
| Residual Oi | $. | /Mbtus | 0 | Mbtus | $0 | 17.23 | $0 |
| Natural Gas | $. | /Mbtus | 0 | Mbtus | $0 | 17.32 | $0 |
| Coal | $. | /Mbtus | 0 | Mbtus | $0 | 14.04 | $0 |
| LPG | $6.5 | /Mbtus | 0 | Mbtus | $0 | 15.64 | $0 |
| Solar | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Geothermal | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Biomass | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Refuse | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Wind | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Other | $7. | /Mbtus | -31 | Mbtus | -$217 | 13.47 | -$2,919 |
| TOTAL | | | 1,985 | Mbtus | $50,103 | | $725,202 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

| | |
|---|---|
| 4. First Year Dollar Savings | $50,103 |
| 5. Simple Payback Period (Years) | 3.58 |
| 6. Total Net Discounted Savings | $725,202 |
| 7. Savings to Investment Ratio | 4.05 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 11.64% |

Life Cycle Cost Analysis — Study: HELSTF.LC

Energy Conservation Investment Program (ECIP) — LCCID FY96

Installation & Location: WSMR

Region data: NEW — Census Region: 4

Project NO. & Title: 03-0185.05 EEAP ENERGY STUDY - HELSTF FACILITY

Fiscal Year: 1997 Discrete Portion: ECO-B

Analysis Date: 08/16/96 Economic Life: 20 years

Prepared by: MICHAEL W. ELLIOTT, P.E., CEM

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $60,653 |
| B. SIOH | $3,023 |
| C. Design Cost | $3,111 |
| D. Total Cost (1A+1B+1C) | $66,787 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $66,787 |

2. Energy Savings (+) / Costs (-)

Date of NISTIR 85-3273-X used for Discount Factors Oct 1995

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $25. | /Mbtus | 1,454 | Mbtus | $36,292 | 14.47 | $525,143 |
| Elec. Deman | | | | | $0 | 13.47 | $0 |
| Distillate | $. | /Mbtus | 0 | Mbtus | $0 | 17.01 | $0 |
| Residual Oi | $. | /Mbtus | 0 | Mbtus | $0 | 17.23 | $0 |
| Natural Gas | $. | /Mbtus | 0 | Mbtus | $0 | 17.32 | $0 |
| Coal | $. | /Mbtus | 0 | Mbtus | $0 | 14.04 | $0 |
| LPG | $6.5 | /Mbtus | 0 | Mbtus | $0 | 15.64 | $0 |
| Solar | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Geothermal | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Biomass | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Refuse | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Wind | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Other | $7. | /Mbtus | -25 | Mbtus | -$175 | 13.47 | -$2,354 |
| TOTAL | | | 1,429 | Mbtus | $36,117 | | $522,789 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

| | |
|---|---|
| 4. First Year Dollar Savings | $36,117 |
| 5. Simple Payback Period (Years) | 1.85 |
| 6. Total Net Discounted Savings | $522,789 |
| 7. Savings to Investment Ratio | 7.83 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 15.38% |

Life Cycle Cost Analysis — Study: HELSTF.LC

Energy Conservation Investment Program (ECIP) — LCCID FY96

Installation & Location: WSMR

Region data: NEW — Census Region: 4

Project NO. & Title: 03-0185.05 EEAP ENERGY STUDY - HELSTF FACILITY

Fiscal Year: 1997 Discrete Portion: ECO-D

Analysis Date: 08/16/96 Economic Life: 20 years

Prepared by: MICHAEL W. ELLIOTT, P.E., CEM

## ECIP Summary Report

1. Investment

| | | |
|---|---|---|
| A. | Construction Cost | 127899 |
| B. | SIOH | 6375 |
| C. | Design Cost | 6561 |
| D. | Total Cost (1A+1B+1C) | $140,835 |
| E. | Salvage Value of Existing Equip. | $0 |
| F. | Public Utility Company Rebate | $0 |
| G. | Total Investment (1D-1E-1F) | $140,835 |

2. Energy Savings (+) / Costs (-)

Date of NISTIR 85-3273-X used for Discount Factors Oct 1995

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $25. | /Mbtus | 1,271 | Mbtus | $31,724 | 14.47 | $459,049 |
| Elec. Deman | | | | | $0 | 13.47 | $0 |
| Distillate | $. | /Mbtus | 0 | Mbtus | $0 | 17.01 | $0 |
| Residual Oi | $. | /Mbtus | 0 | Mbtus | $0 | 17.23 | $0 |
| Natural Gas | $. | /Mbtus | 0 | Mbtus | $0 | 17.32 | $0 |
| Coal | $. | /Mbtus | 0 | Mbtus | $0 | 14.04 | $0 |
| LPG | $6.5 | /Mbtus | 0 | Mbtus | $0 | 15.64 | $0 |
| Solar | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Geothermal | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Biomass | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Refuse | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Wind | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Other | $7. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| TOTAL | | | 1,271 | Mbtus | $31,724 | | $459,049 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

| | |
|---|---|
| 4. First Year Dollar Savings | $31,724 |
| 5. Simple Payback Period (Years) | 4.44 |
| 6. Total Net Discounted Savings | $459,049 |
| 7. Savings to Investment Ratio | 3.26 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 10.44% |

Life Cycle Cost Analysis Study: HELSTF.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: WSMR
Region data: NEW Census Region: 4
Project NO. & Title: 03-0185.05 EEAP ENERGY STUDY - HELSTF FACILITY
Fiscal Year: 1997 Discrete Portion: ECO-E
Analysis Date: 08/16/96 Economic Life: 20 years
Prepared by: MICHAEL W. ELLIOTT, P.E., CEM

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $47,625 |
| B. SIOH | $2,356 |
| C. Design Cost | $2,425 |
| D. Total Cost (1A+1B+1C) | $52,406 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $52,406 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1995

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $25. | /Mbtus | 357 | Mbtus | $8,911 | 14.47 | $128,938 |
| Elec. Deman | | | | | $0 | 13.47 | $0 |
| Distillate | $. | /Mbtus | 0 | Mbtus | $0 | 17.01 | $0 |
| Residual Oi | $. | /Mbtus | 0 | Mbtus | $0 | 17.23 | $0 |
| Natural Gas | $. | /Mbtus | 0 | Mbtus | $0 | 17.32 | $0 |
| Coal | $. | /Mbtus | 0 | Mbtus | $0 | 14.04 | $0 |
| LPG | $6.5 | /Mbtus | 0 | Mbtus | $0 | 15.64 | $0 |
| Solar | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Geothermal | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Biomass | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Refuse | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Wind | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Other | $7. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| TOTAL | | | 357 | Mbtus | $8,911 | | $128,938 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

| | |
|---|---|
| 4. First Year Dollar Savings | $8,911 |
| 5. Simple Payback Period (Years) | 5.88 |
| 6. Total Net Discounted Savings | $128,938 |
| 7. Savings to Investment Ratio | 2.46 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 8.89% |

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - LSTC AND TEST CELL 1

**ECO NO.** A

**PROJECT NO:** 03-0185.05 **DATE:** 8/20/96

**BY :** HOWARD, D. **CHECKED BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install T-8 Lamps and Electronic Ballasts In 4' Fluorescent Light Fixtures and Compact Fluorescent Lamps in Incandescent Fixtures. Upgrade Exit Lights with LED Kit.

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Installation of new F32T8 electronic ballasts & sockets - 1-lamp | 1 | ea | 1.0 | 30.00 | 30 | 26.80 | 27 | 57 |
| Installation of new F32T8 electronic ballasts & sockets - 2-lamp | 1,109 | ea | 1.0 | 30.00 | 33,270 | 26.80 | 29,721 | 62,991 |
| Installation of new F32T8 electronic ballasts & sockets - 3-lamp | 58 | ea | 1.0 | 30.00 | 1,740 | 34.00 | 1,972 | 3,712 |
| Installation of new F32T8 electronic ballasts & sockets - 4-lamp | 285 | ea | 1.0 | 30.00 | 8,550 | 34.00 | 9,690 | 18,240 |
| Installation of new F32T8 lamps | 3,533 | ea | 0.2 | 30.00 | 21,198 | 2.02 | 7,137 | 28,335 |
| Install 26W compact fluorescent lamps in existing fixtures | 37 | ea | 0.2 | 30.00 | 222 | 21.70 | 803 | 1,025 |
| Install LED retrofit lamp kit in existing exit fixtures | 37 | ea | 1.0 | 30.00 | 1,110 | 12.60 | 466 | 1,576 |
| | | | | SUBTOTAL | 66,120 | | 49,816 | 115,936 |
| | | | | O & P @ 20% | 13,224 | | 9,963 | 23,187 |
| | | | | SUBTOTAL | 79,344 | | 59,779 | 139,123 |
| | | | | DESIGN @ 6% | | | | 8,347 |
| | | | | SUBTOTAL | | | | 147,470 |
| | | | | SIOH @ 5.5% | | | | 8,111 |
| | | | | NMGRT @ 6% | | | | 8,848 |
| | | | | AREA ADJUST. @ 10% | | | | 14,747 |
| | | | | TOTAL | | | | $179,176 |


**HUITT-ZOLLARS, INC.**
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(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - LSTC AND TEST CELL 1 | **PROJECT NO:** 03-0185.05 | **DATE:** 8/20/96

**ECO NO. B** | **BY:** HOWARD, D. | **CHECKED BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install Occupancy Sensors To Turn Off Lights

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Install occupancy sensors in various rooms | 201 | ea | 2.0 | 30.00 | 12,060 | 100.00 | 20,100 | 32,160 |
| Miscellaneous wire, conduit and electrical parts | 201 | ea | 1.0 | 30.00 | 6,030 | 25.00 | 5,025 | 11,055 |
| SUBTOTAL | | | | | 18,090 | | 25,125 | 43,215 |
| O & P @ 20% | | | | | 3,618 | | 5,025 | 8,643 |
| SUBTOTAL | | | | | 21,708 | | 30,150 | 51,858 |
| DESIGN @ 6% | | | | | | | | 3,111 |
| SUBTOTAL | | | | | | | | 54,969 |
| SIOH @ 5.5% | | | | | | | | 3,023 |
| NMGRT @ 6% | | | | | | | | 3,298 |
| AREA ADJUST. @ 10% | | | | | | | | 5,497 |
| TOTAL | | | | | | | | $66,787 |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - LSTC

**ECO NO.** D

**PROJECT NO:** 03-0185.05 **DATE:** 8/20/96

**BY:** KOTHMAN, K. **CHECKED BY:** HOWARD, D.

**PROJECT DESCRIPTION:** VAV CONTROLS RETROFIT

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Install variable frequency drive and static pressure controller | | | | | | | | |
| on existing air handling unit (3ph 480v) | | | | | | | | |
| 10ph | 2 | ea | 10.7 | 24.62 | 527 | 857.00 | 1,714 | 2,241 |
| 15 hp | 2 | ea | 11.0 | 24.62 | 542 | 905.00 | 1,810 | 2,352 |
| 25 hp | 2 | ea | 13.8 | 24.62 | 680 | 1,140.00 | 2,280 | 2,960 |
| 40 ph | 1 | ea | 16.0 | 24.62 | 394 | 2,550.00 | 2,550 | 2,944 |
| Remove pneumatic t-stat | 43 | ea | 1.0 | 22.91 | 985 | | | 985 |
| Install new pneumatic t-stat | 112 | ea | 1.5 | 24.62 | 4,136 | 136.00 | 15,232 | 19,368 |
| Test and balance | 1 | job | 160.0 | 24.00 | 3,840 | | | 3,840 |
| SUBTOTAL FROM PAGE 2 | | | | | 20,688 | | 35,750 | 56,438 |
| | | | | SUBTOTAL | 31,792 | | 59,336 | 91,128 |
| | | | | O & P @ 20% | 6,358 | | 11,867 | 18,225 |
| | | | | SUBTOTAL | 38,150 | | 71,203 | 109,353 |
| | | | | DESIGN @ 6% | | | | 6,561 |
| | | | | SUBTOTAL | | | | 115,914 |
| | | | | SIOH @ 5.5% | | | | 6,375 |
| | | | | NMGRT @ 6% | | | | 6,955 |
| | | | | AREA ADJUST. @ 10% | | | | 11,591 |
| | | | | TOTAL | | | | $140,835 |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: HELSTF - LSTC | PROJECT NO: 03-0185.05 | DATE: 8/20/96

ECO NO. D | BY : KOTHMAN, K. | CHECKED BY: HOWARD, D.

PROJECT DESCRIPTION: VAV CONTROLS RETROFIT .

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Retrofit variable volume terminal | | | | | | | | |
| Size B to 300 CFM | 26 | ea | 2.5 | 22.91 | 1,489 | 235.00 | 6,110 | 7,599 |
| Size C 200 to 400 CFM | 20 | ea | 3.0 | 22.91 | 1,375 | 235.00 | 4,700 | 6,075 |
| Size D 350 to 700 CFM | 18 | 5 | 3.0 | 22.91 | 1,237 | 240.00 | 4,320 | 5,557 |
| Size E 500 to 1000 CFM | 12 | ea | 3.5 | 22.91 | 962 | 250.00 | 3,000 | 3,962 |
| Size J 1000 to 2400 CFM | 16 | ea | 3.5 | 22.91 | 1,283 | 275.00 | 4,400 | 5,500 |
| Size M 1800 to 5400 CFM | 12 | ea | 4.0 | 22.91 | 1,100 | 280.00 | 3,360 | 4,047 |
| Size P 4000 to 10000 CFM | 6 | ea | 5.0 | 22.91 | 687 | 300.00 | 1,800 | 2,487 |
| Size R 5000 to 15000 CFM | 2 | ea | 6.0 | 22.91 | 275 | 390.00 | 780 | 1,055 |
| | | | | | | | | |
| Misc pneumatic piping and connect | 112 | ea | 3.5 | 22.91 | 8,981 | 60.00 | 6,720 | 15,701 |
| Remove/replace/repair ceiling as required | 1 | job | 144.0 | 22.91 | 3,299 | 560.00 | 560 | 3,859 |
| SUBTOTAL PAGE 2 | | | | | 20,688 | | 35,750 | 56,438 |
| SUBTOTAL | | | | | | | | |
| O & P @ 20% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| DESIGN @ 6% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| SIOH @ 5.5% | | | | | | | | |
| NMGRT @ 6% | | | | | | | | |
| AREA ADJUST. @ 10% | | | | | | | | |
| TOTAL | | | | | | | | |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - LSTC, TEST CELL 1 & 2

**PROJECT NO:** 03-0185.05

**DATE:** 8/20/96

**ECO NO.** E

**BY :** HOWARD, D.

**CHECKED BY:** HOWARD, D.

**PROJECT DESCRIPTION:** Install Energy Efficient Motors

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Install 1 HP energy efficient motor | | ea | 1.8 | 30.00 | | 182.00 | | |
| Install 1.5 HP energy efficient motor | 1 | ea | 1.8 | 30.00 | 54 | 210.00 | 210 | 264 |
| Install 2 HP energy efficient motor | 2 | ea | 1.8 | 30.00 | 108 | 239.00 | 478 | 586 |
| Install 3 HP energy efficient motor | 4 | ea | 1.8 | 30.00 | 216 | 250.00 | 1,000 | 1,216 |
| Install 5 HP energy efficient motor | 7 | ea | 1.8 | 30.00 | 378 | 300.00 | 2,100 | 2,478 |
| Install 7.5 HP energy efficient motor | 11 | ea | 1.9 | 30.00 | 627 | 370.00 | 4,070 | 4,697 |
| Install 10 HP energy efficient motor | 4 | ea | 2.0 | 30.00 | 240 | 460.00 | 1,840 | 2,080 |
| Install 15 HP energy efficient motor | 7 | ea | 2.5 | 30.00 | 525 | 695.00 | 4,865 | 5,390 |
| Install 25 HP energy efficient motor | 3 | ea | 3.2 | 30.00 | 288 | 1,075.00 | 3,225 | 3,513 |
| Install 30 HP energy efficient motor | 4 | ea | 3.3 | 30.00 | 396 | 1,250.00 | 5,000 | 5,396 |
| Install 40 HP energy efficient motor | 3 | ea | 4.0 | 30.00 | 360 | 1,675.00 | 5,025 | 5,385 |
| Install 60 HP energy efficient motor | 1 | ea | 5.7 | 30.00 | 171 | 2,500.00 | 2,500 | 2,671 |
| | | | | SUBTOTAL | 3,363 | | 30,313 | 33,676 |
| | | | | O & P @ 20% | 673 | | 6,063 | 6,736 |
| | | | | SUBTOTAL | 4,036 | | 36,376 | 40,412 |
| | | | | DESIGN @ 6% | | | | 2,425 |
| | | | | SUBTOTAL | | | | 42,837 |
| | | | | SIOH @ 5.5% | | | | 2,356 |
| | | | | NMGRT @ 6% | | | | 2,570 |
| | | | | AREA ADJUST. @ 10% | | | | 4,284 |
| | | | | TOTAL | | | | $52,046 |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - LSTC | **PROJECT NO:** 03-0185.05 | **DATE:** 8/20/96

**ECO NO.** E | **BY :** HOWARD, D. | **CHECKED BY:** HOWARD, D.

**PROJECT DESCRIPTION:** Install Energy Efficient Motors

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Install 1 HP energy efficient motor | | ea | 1.8 | 30.00 | | 182.00 | | |
| Install 1.5 HP energy efficient motor | 1 | ea | 1.8 | 30.00 | 54 | 210.00 | 210 | 264 |
| Install 2 HP energy efficient motor | 1 | ea | 1.8 | 30.00 | 54 | 239.00 | 239 | 293 |
| Install 3 HP energy efficient motor | 1 | ea | 1.8 | 30.00 | 54 | 250.00 | 250 | 304 |
| Install 5 HP energy efficient motor | 4 | ea | 1.8 | 30.00 | 216 | 300.00 | 1,200 | 1,416 |
| Install 7.5 HP energy efficient motor | 3 | ea | 1.9 | 30.00 | 171 | 370.00 | 1,110 | 1,281 |
| Install 10 HP energy efficient motor | 2 | ea | 2.0 | 30.00 | 120 | 460.00 | 920 | 1,040 |
| Install 15 HP energy efficient motor | 4 | ea | 2.5 | 30.00 | 300 | 695.00 | 2,780 | 3,080 |
| Install 25 HP energy efficient motor | 3 | ea | 3.2 | 30.00 | 288 | 1,075.00 | 3,225 | 3,513 |
| Install 30 HP energy efficient motor | 2 | ea | 3.3 | 30.00 | 198 | 1,250.00 | 2,500 | 2,698 |
| Install 40 HP energy efficient motor | 1 | ea | 4.0 | 30.00 | 120 | 1,675.00 | 1,675 | 1,795 |
| Install 60 HP energy efficient motor | 1 | ea | 5.7 | 30.00 | 171 | 2,500.00 | 2,500 | 2,671 |
| | | | | SUBTOTAL | 1,746 | | 16,609 | 18,355 |
| | | | | O & P @ 20% | 349 | | 3,322 | 3,671 |
| | | | | SUBTOTAL | 2,095 | | 19,931 | 22,026 |
| | | | | DESIGN @ 6% | | | | 1,322 |
| | | | | SUBTOTAL | | | | 23,348 |
| | | | | SIOH @ 5.5% | | | | 1,284 |
| | | | | NMGRT @ 6% | | | | 1,401 |
| | | | | AREA ADJUST. @ 10% | | | | 2,335 |
| | | | | TOTAL | | | | $28,368 |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - TEST CELL 1 & 2 | **PROJECT NO:** 03-0185.05 | **DATE:** 8/20/96

**ECO NO.** E | **BY :** HOWARD, D. | **CHECKED BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install Energy Efficient Motors

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Install 1 HP energy efficient motor | | ea | 1.8 | 30.00 | | 182.00 | | |
| Install 1.5 HP energy efficient motor | | ea | 1.8 | 30.00 | | 210.00 | | |
| Install 2 HP energy efficient motor | 1 | ea | 1.8 | 30.00 | 54 | 239.00 | 239 | 293 |
| Install 3 HP energy efficient motor | 3 | ea | 1.8 | 30.00 | 162 | 250.00 | 750 | 912 |
| Install 5 HP energy efficient motor | 3 | ea | 1.8 | 30.00 | 162 | 300.00 | 900 | 1,062 |
| Install 7.5 HP energy efficient motor | 8 | ea | 1.9 | 30.00 | 456 | 370.00 | 2,960 | 3,416 |
| Install 10 HP energy efficient motor | 2 | ea | 2.0 | 30.00 | 120 | 460.00 | 920 | 1,040 |
| Install 15 HP energy efficient motor | 3 | ea | 2.5 | 30.00 | 225 | 695.00 | 2,085 | 2,310 |
| Install 25 HP energy efficient motor | | ea | 3.2 | 30.00 | | 1,075.00 | | |
| Install 30 HP energy efficient motor | 2 | ea | 3.3 | 30.00 | 198 | 1,250.00 | 2,500 | 2,698 |
| Install 40 HP energy efficient motor | 2 | ea | 4.0 | 30.00 | 240 | 1,675.00 | 3,350 | 3,590 |
| Install 60 HP energy efficient motor | | ea | 5.7 | 30.00 | | 2,500.00 | | |
| | | | | SUBTOTAL | 1,617 | | 13,704 | 15,321 |
| | | | | O & P @ 20% | 323 | | 2,741 | 3,064 |
| | | | | SUBTOTAL | 1,940 | | 16,445 | 18,385 |
| | | | | DESIGN @ 6% | | | | 1,103 |
| | | | | SUBTOTAL | | | | 19,488 |
| | | | | SIOH @ 5.5% | | | | 1,072 |
| | | | | NMGRT @ 6% | | | | 1,169 |
| | | | | AREA ADJUST. @ 10% | | | | 1,949 |
| | | | | TOTAL | | | | $23,678 |

**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

| 1. COMPONENT ARMY | FY 1997 MILITARY CONSTRUCTION PROJECT DATA | 2. DATE 8/23/96 |
|---|---|---|

| 3. INSTALLATION AND LOCATION | 4. PROJECT TITLE |
|---|---|
| HELSTF, WHITE SANDS MISSILE RANGE, NM. | ECIP - Energy Mgmt System, Project 2 |

| 5. PROGRAM ELEMENT | 6. CATAGORY CODE | 7. PROJECT NUMBER | 8. PROJECT COST ($000) |
|---|---|---|---|
| | | | 443.021 |

9. COST ESTIMATES

| ITEM | U/M | QUANTITY | UNIT COST | COST ($000) |
|---|---|---|---|---|
| ENERGY MANAGEMENT SYSTEM | EA | 1 | 443.0 | 443.0 |
| ESTIMATED CONTRACT COST | | | | 402.328 |
| CONTINGENCY (0%) | | | | 0.0 |
| SIOH | | | | 20.054 |
| DESIGN | | | | 20.639 |
| TOTAL REQUEST | | | | 443.021 |
| TOTAL REQUEST (ROUNDED) | | | | 443.000 |

10. DESCRIPTION OF PROPOSED CONSTRUCTION

Install Energy Management System (EMS) at the LSTC, TC-1 and TC-2 buildings. The EMS will be equipped with standalone DDC controllers with fully distributed processing capabilities. These controllers will communicate with each other as well as with a personal computer based operator workstation. The operator workstation will be installed in the LSTC building to monitor and control the HVAC systems in each building. Buildings TC-1 and TC-2 will communicate with the operator workstation via telephone lines. HVAC equipment including air handling units, exhaust fans and chillers in each of the three buildings will be monitored and controlled by the EMS.

The EMS will provide the following control strategies to reduce HVAC system energy consumption:

1. Optimal start/stop control
2. Direct Digital Control (DDC)
3. Outside air economizer cycles
4. Chilled water reset
5. Condenser water reset
6. Programmed start/stop control.

DD FORM 1 DEC 76 1391

| 1. COMPONENT ARMY | FY 1997 MILITARY CONSTRUCTION PROJECT DATA | 2. DATE 8/23/96 |
|---|---|---|

3. INSTALLATION AND LOCATION
HELSTF, WHITE SANDS MISSILE RANGE, NM.

| 4. PROJECT TITLE | 5. PROJECT NUMBER |
|---|---|
| ECIP - Energy Management System, Project 2 | |

11. REQUIREMENT

The project is required to reduce HVAC systems energy consumption at HELSTF. The project provide more energy efficient control of air handling systems, fans, pumps, chillers, etc. All buildings included in this project will be active throughout the payback period. Installation of these retrofits will result in the following:

| | | |
|---|---|---|
| Electrical Energy Savings | 4,419 | MMBTU/yr |
| Diesel Energy Savings | 542 | MMBTU/yr |
| Total Energy Savings | 4,961 | MMBTU/yr |
| Total Cost Savings | 114,087 | $/yr |
| Total Investment | 443,021 | $ |
| Simple Payback | 3.88 | yrs |
| SIR | 3.72 | |

CURRENT SITUATION:

A. Installing an EMS is intended to coordinate all of the existing controls and add controls that will not only save energy costs, but will also save maintenance costs as well.

B. AHU-S1, which provides conditioned outside air to AHUs 1, 2, 3, 5, 6, 7, and 13 in the LSTC building, will be equipped with a variable frequency drive and static pressure controls to reduce to outside air cfm to match the current outside air requirements of the LSTC. Outside air ventilation requirements are based on 20 cfm per person as required by ASHRAE 62-1989. An outside air economizer cycle will also be added to AHU-S1, to provide free cooling when the outside air conditions are favorable.

C. AHUs 1, 2, 3, 5, 6, and 7 presently operate 24 hours per day, 365 days a year, while the spaces served by these AHU are occupied from 7 am to 4 pm, Monday through Friday. These AHU will be started/stopped by the EMS to ensure that the AHU operate only during times that the associated space is occupied. These AHU will also be controlled by a night setback/setup control strategy, that will ensure that the space temperature stays below 85 degrees during the summertime and above 65 degrees in the wintertime.

D. All multizone AHU and single zone AHU will be equipped with DDC controls to maintain the space temperature and space humidity setpoints in the spaces served by the respective AHU. Outside air economizer cycles will also be implemented for those AHU serving Building TC-1.

E. Chillers CH-51 and CH-52 are presently equipped with chilled water and condenser water reset controls. As the differential pressure between the evaporator and condenser decreases, the energy required to operate the chiller compressor also decreases. The cooling tower will be controlled by the condenser water reset program to provide colder condenser water to the chiller. The condenser water reset program will consider prevailing outdoor conditions as part of the reset algorithm.

F. Exhaust fan EF-2 and circulation pump P-5 will be controlled by the EMS on a time schedule, as both pieces of equipment presently operate 24 hours per day, 365 days a year.

IMPACT IF NOT PROVIDED

If this project is not provided, the above mentioned savings in cooling energy and costs will continue to be wasted. There will be no contribution to the energy reduction goals established at the facility.

Life Cycle Cost Analysis — Study: HELSTF.LC

Energy Conservation Investment Program (ECIP) — LCCID FY96

Installation & Location: WSMR

Region data: NEW — Census Region: 4

Project NO. & Title: 03-0185.05 EEAP ENERGY STUDY - HELSTF FACILITY

Fiscal Year: 1997 Discrete Portion: PROJECT 2

Analysis Date: 08/20/96 Economic Life: 20 years

Prepared by: Michael W. Elliott, P.E., CEM

## ECIP Summary Report

1. Investment

| | | |
|---|---|---|
| A. | Construction Cost | 402328 |
| B. | SIOH | 20054 |
| C. | Design Cost | 20639 |
| D. | Total Cost (1A+1B+1C) | $443,021 |
| E. | Salvage Value of Existing Equip. | $0 |
| F. | Public Utility Company Rebate | $0 |
| G. | Total Investment (1D-1E-1F) | $443,021 |

2. Energy Savings (+) / Costs (-)

Date of NISTIR 85-3273-X used for Discount Factors Oct 1995

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $25. | /Mbtus | 4,419 | Mbtus | $110,298 | 14.47 | $1,596,016 |
| Elec. Deman | | | | | $0 | 13.47 | $0 |
| Distillate | $. | /Mbtus | 0 | Mbtus | $0 | 17.01 | $0 |
| Residual Oi | $. | /Mbtus | 0 | Mbtus | $0 | 17.23 | $0 |
| Natural Gas | $. | /Mbtus | 0 | Mbtus | $0 | 17.32 | $0 |
| Coal | $. | /Mbtus | 0 | Mbtus | $0 | 14.04 | $0 |
| LPG | $6.5 | /Mbtus | 0 | Mbtus | $0 | 15.64 | $0 |
| Solar | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Geothermal | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Biomass | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Refuse | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Wind | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Other | $7. | /Mbtus | 542 | Mbtus | $3,789 | 13.47 | $51,032 |
| TOTAL | | | 4,961 | Mbtus | $114,087 | | $1,647,048 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

| | | |
|---|---|---|
| 4. | First Year Dollar Savings | $114,087 |
| 5. | Simple Payback Period (Years) | 3.88 |
| 6. | Total Net Discounted Savings | $1,647,048 |
| 7. | Savings to Investment Ratio | 3.72 |
| | If < 1, Project does not qualify | |
| | Adjusted Internal Rate of Return | 11.16% |

Life Cycle Cost Analysis                                      Study: HELSTF.LC
Energy Conservation Investment Program (ECIP)                LCCID FY96
Installation & Location: WSMR
Region data: NEW                Census Region: 4
Project NO. & Title: 03-0185.05 EEAP ENERGY STUDY - HELSTF FACILITY
Fiscal Year: 1997 Discrete Portion: ECO-C
Analysis Date: 08/16/96 Economic Life: 20 years
Prepared by: MICHAEL W. ELLIOTT, P.E., CEM

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | 402328 |
| B. SIOH | 20054 |
| C. Design Cost | 20639 |
| D. Total Cost (1A+1B+1C) | $443,021 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $443,021 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1995

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $25. | /Mbtus | 4,419 | Mbtus | $110,298 | 14.47 | $1,596,016 |
| Elec. Deman | | | | | $0 | 13.47 | $0 |
| Distillate | $. | /Mbtus | 0 | Mbtus | $0 | 17.01 | $0 |
| Residual Oi | $. | /Mbtus | 0 | Mbtus | $0 | 17.23 | $0 |
| Natural Gas | $. | /Mbtus | 0 | Mbtus | $0 | 17.32 | $0 |
| Coal | $. | /Mbtus | 0 | Mbtus | $0 | 14.04 | $0 |
| LPG | $6.5 | /Mbtus | 0 | Mbtus | $0 | 15.64 | $0 |
| Solar | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Geothermal | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Biomass | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Refuse | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Wind | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Other | $7. | /Mbtus | 542 | Mbtus | $3,789 | 13.47 | $51,032 |
| TOTAL | | | 4,961 | Mbtus | $114,087 | | $1,647,048 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

| | |
|---|---|
| 4. First Year Dollar Savings | $114,087 |
| 5. Simple Payback Period (Years) | 3.88 |
| 6. Total Net Discounted Savings | $1,647,048 |
| 7. Savings to Investment Ratio | 3.72 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 11.16% |

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - LSTC TEST CELL 1 AND 2 | **PROJECT NO:** 03-0185.05 | **DATE:** 8/20/96

**ECO NO. C** | **BY:** KOTHMAN, K. | **CHECKED BY:** HOWARD, D.

**PROJECT DESCRIPTION:** Install Energy Management System To Control HVAC Equipment

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| EMCS submittals | 1 | job | | | | 5,000.00 | 5,000 | 5,000 |
| Training | 1 | job | | | | 1,000.00 | 1,000 | 1,000 |
| System test & start-up | 1 | job | | | | 5,300.00 | 5,300 | 5,300 |
| The following Point Cost Summary includes common | | | | | | | | |
| costs and circuits | | | | | | | | |
| Equipment on/off status | 6 | ea | 12.0 | 30.00 | 2,160 | 175.74 | 1,054 | 3,214 |
| Control relay | 46 | ea | 2.0 | 30.00 | 2,760 | 29.00 | 1,334 | 4,094 |
| Control point adjustment | 1 | ea | 14.0 | 30.00 | 420 | 936.12 | 936 | 1,356 |
| Position adjustment | 1 | ea | 14.0 | 30.00 | 420 | 528.96 | 529 | 949 |
| UMCS control actuator | 44 | ea | 13.0 | 30.00 | 17,160 | 405.50 | 17,842 | 35,002 |
| SUBTOTAL FROM PAGE 2 | | | | | 99,630 | | 107,680 | 207,310 |
| SUBTOTAL FROM PAGE 3 | | | | | 2,640 | | 20,791 | 23,431 |
| SUBTOTAL | | | | | 125,190 | | 161,466 | 286,656 |
| O & P @ 20% | | | | | 25,038 | | 32,293 | 57,331 |
| SUBTOTAL | | | | | 150,228 | | 193,759 | 343,987 |
| DESIGN @ 6% | | | | | | | | 20,639 |
| SUBTOTAL | | | | | | | | 364,626 |
| SIOH @ 5.5% | | | | | | | | 20,054 |
| NMGRT @ 6% | | | | | | | | 21,878 |
| AREA ADJUST. @ 10% | | | | | | | | 36,463 |
| TOTAL | | | | | | | | $443,021 |


**HUITT-ZOLLARS, INC.**

**ENGINEERS / ARCHITECTS**

512 MAIN STREET, SUITE 1500

FORT WORTH, TEXAS 76102-3922

(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | |
|---|---|---|
| LOCATION: HELSTF - LSTC AND TEST CELL 1 AND 2 | PROJECT NO: 03-0185.05 | DATE: 8/20/96 |
| ECO NO. C | BY : KOTHMAN, K. | CHECKED BY: HOWARD, D. |

**PROJECT DESCRIPTION:** Install Energy Management System To Control HVAC Equipment

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Differential pressure switch | 25 | ea | 10.0 | 30.00 | 7,500 | 225.00 | 5,625 | 13,125 |
| Auxiliary contact | 2 | ea | 2.0 | 30.00 | 120 | 26.42 | 53 | 173 |
| Current sensor/relay | 46 | ea | 2.0 | 30.00 | 2,760 | 29.00 | 1,334 | 4,094 |
| Temperature sensor/hydronic | 30 | ea | 18.0 | 30.00 | 16,200 | 26.42 | 793 | 16,993 |
| Temperature senosr/space | 123 | ea | 13.0 | 30.00 | 47,970 | 556.00 | 68,388 | 116,358 |
| Temperature sensor flue gas | 2 | ea | 13.0 | 30.00 | 780 | 534.00 | 1,068 | 1,848 |
| Relative Humidity sensor | 43 | ea | 14.0 | 30.00 | 18,060 | 615.00 | 26,445 | 44,505 |
| Flow sensor | 11 | ea | 12.0 | 30.00 | 3,960 | 210.00 | 2,310 | 6,270 |
| Pressure sensor | 4 | ea | 10.0 | 30.00 | 1,200 | 197.00 | 788 | 1,988 |
| AMP/meter/A.I. | 4 | ea | 9.0 | 30.00 | 1,080 | 219.00 | 876 | 1,956 |
| SUBTOTAL PAGE 2 | | | | | 99,630 | | 107,680 | 207,310 |
| SUBTOTAL | | | | | | | | |
| O & P @ 20% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| DESIGN @ 6% | | | | | | | | |
| SUBTOTAL | | | | | | | | |
| SIOH @ 5.5% | | | | | | | | |
| NMGRT @ 6% | | | | | | | | |
| AREA ADJUST. @ 10% | | | | | | | | |
| TOTAL | | | | | | | | |

**HUITT-ZOLLARS, INC.**
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - LSTC AND TEST CELL 1 AND 2
**PROJECT NO:** 03-0185.05
**DATE:** 8/20/96
**ECO NO. C**
**BY :** KOTHMAN, K.
**CHECKED BY:** HOWARD, D.

**PROJECT DESCRIPTION:** Install Energy Management System to Control HVAC Equipment

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Electrical metering watts/vars A.1 | 2 | ea | 12.0 | 30.00 | 720 | 440.00 | 880 | 1,600 |
| Operators consol control unit | 1 | ea | | | | 13,184.00 | 13,184 | 13,184 |
| Alarm printer | 1 | ea | | | | 900.00 | 900 | 900 |
| Software included above: | | | | | | | | |
| Communication modem device and remote panel | 2 | ea | 24.0 | 30.00 | 1,440 | 2,500.00 | 5,000 | 6,440 |
| 7-1/2 HP VFD FOR AHU-S1, WITH SP CONTROLER | 1 | EA | 12.0 | 30.00 | 360 | 800.00 | 800 | 1,160 |
| CONTROL CIRCUITS | 1 | EA | 4.0 | 30.00 | 120 | 26.60 | 27 | 147 |
| SUBTOTAL PAGE 3 | | | | | 2,640 | | 20,791 | 23,431 |
| | | | | SUBTOTAL | | | | |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | NMGRT @ 6% | | | | |
| | | | | AREA ADJUST. @ 10% | | | | |
| | | | | TOTAL | | | | |


**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

| 1. COMPONENT ARMY | FY 1997 MILITARY CONSTRUCTION PROJECT DATA | 2. DATE 8/23/96 |
|---|---|---|

| 3. INSTALLATION AND LOCATION | 4. PROJECT TITLE |
|---|---|
| HELSTF, WHITE SANDS MISSILE RANGE, NM. | ECIP - Boiler/Chiller Retrofit, Project 3 |

| 5. PROGRAM ELEMENT | 6. CATAGORY CODE | 7. PROJECT NUMBER | 8. PROJECT COST ($000) |
|---|---|---|---|
| | | | 694.623 |

9. COST ESTIMATES

| ITEM | U/M | QUANTITY | UNIT COST | COST ($000) |
|---|---|---|---|---|
| CHILLER RETROFIT - LSTC BUILDING | EA | 1 | 415.2 | 415.174 |
| CHILLER RETROFIT - TC-2 BUILDING | EA | 1 | 184.3 | 248.890 |
| BOILER RETROFIT - TC-2 BUILDING | EA | 1 | 30.56 | 30.559 |
| ESTIMATED CONTRACT COST | | | | 630.818 |
| CONTINGENCY (0%) | | | | 0.0 |
| SIOH | | | | 31.444 |
| DESIGN | | | | 32.361 |
| TOTAL REQUEST | | | | 694.623 |
| TOTAL REQUEST (ROUNDED) | | | | 695.000 |

10. DESCRIPTION OF PROPOSED CONSTRUCTION

A. Remove the three existing centrifugal chillers serving the LSTC building. Replace chillers with one reciprocating chiller and two screw chillers. Re-pipe the existing chilled water and condenser water piping into a parallel configuration. Remove existing chilled water and condenser water pumps and replace pumps with new pumps sized for the application. Remove the existing oil fired steam boiler in the LSTC basement and replace it with new, propane fired hot water boiler. Replace flue. Remove diesel fuel piping and fuel tanks. Provide 400 gallon above ground fuel tank. Remove existing heating water pump and replace with new pump. Remove the existing 39 steam terminal reheat coils and replace them with an equal number of hot water coils. Provide refrigerant leak and propane gas detection systems. Provide new boiler chemical treatment system. Connect equipment to EMS.

B. Remove the two existing centrifugal chillers serving Building TC-2. Replace chillers with two R-123 screw chillers. Remove existing condenser water pumps and replace with new pumps. Re-use existing chilled water pumps. Re-connect all existing controls. Provide refrigerant leak detection system. Install new controls as required. Connect chillers to EMS.

C. Remove one of the existing diesel fired hot water boilers located on TC-2 mezzanine. Abate asbestos as required. Replace boiler with new diesel fired hot water boiler. Re-use existing flue and feedwater piping. Remove existing heat exchanger, primary hot water pumps and expansion tank. Re-pipe secondary piping from secondary hot water pumps to boiler hot water header. Purge entire system with propylene glycol. Connect boilers to EMS.

DD FORM 1 DEC 76 1391

| 1. COMPONENT ARMY | FY 1997 MILITARY CONSTRUCTION PROJECT DATA | 2. DATE 8/23/96 |
|---|---|---|

3. INSTALLATION AND LOCATION
HELSTF, WHITE SANDS MISSILE RANGE, NM.

| 4. PROJECT TITLE ECIP | 5. PROJECT NUMBER |
|---|---|

11. REQUIREMENT

The project is required to reduce chilled water and hot water system energy consumption at HELSTF. The project provides more energy efficient chilled water and hot water systems. All buildings included in this project will be active throughout the payback period. Installation of these retrofits will result in the following:

| | | |
|---|---|---|
| Electrical Energy Savings | 3,297 | MMBTU/yr |
| Diesel Energy Savings | 296 | MMBTU/yr |
| LP Gas Energy Savings | -906 | MMBTU/yr |
| Total Energy Savings | 2,687 | MMBTU/yr |
| Total Cost Savings | 78,509 | $/yr |
| Total Investment | 694,623 | $ |
| Simple Payback | 8.85 | yrs |
| SIR | 1.62 | |

CURRENT SITUATION:

A. With the implementation of previous ECOs, the peak cooling load in the LSTC building would be 175 tons. To satisfy this load with the existing chillers would mean operating at an inefficient, low load condition. The existing series piping configuration of two chillers requires that the existing 60 HP chilled water pump operate continuously, regardless of cooling loads. The existing chillers use R-11 refrigerant, are approximately 13 years old and are in poor condition. Due to the reduction in chiller size, the heat recovery package previously used to produce hot water fo the building would make the chillers inefficient. A modular hot water boiler will be added to satisfy the building heating requirements.

B. The existing water-cooled, R-11 centrifugal chillers in TC-2 are approximately 14 years old and are in fair to poor condition. Due to the fact that R-11 is no longer manufactured, both chillers should be replaced with newer, more efficient chillers with R-123 refrigerant. The condenser water system previously consisted of two independent loops used to cool test equipment. Since the test equipment is no longer cooled with condenser water, the pumps serving these loops should be removed and replaced with pumps sized to serve the two chillers replaced as part of this project.

C. Both of the existing boilers serving Building TC-2 are approximately 14 years old and are relatively inefficient when compared to modern, modular hot water boilers. By replacing one of the existing boilers with a higher efficiency boiler (80%) and removing the existing heat exchanger and primary hot water pumps, both diesel cost savings and electrical cost savings will be realized. With the removal of the heat exchanger, the existing secondary hot water pumps are presently capable of providing full water flow the hot water boilers. Since the replacement boiler will be the primary boiler, with the other existing boiler being used in backup situations only, the overall hot water system efficiency will be increased from 65% to 80%.

IMPACT IF NOT PROVIDED

If this project is not provided, the above mentioned savings in heating and cooling energy and costs will continue to be wasted. There will be no contribution to the energy reduction goals established at the facility.

Life Cycle Cost Analysis — Study: HELSTF.LC

Energy Conservation Investment Program (ECIP) — LCCID FY96

Installation & Location: WSMR

Region data: NEW — Census Region: 4

Project NO. & Title: 03-0185.05 EEAP ENERGY STUDY - HELSTF FACILITY

Fiscal Year: 1997 Discrete Portion: PROJECT 3

Analysis Date: 08/20/96 Economic Life: 20 years

Prepared by: Michael W. Elliott, P.E., CEM

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | 630818 |
| B. SIOH | 31444 |
| C. Design Cost | 32361 |
| D. Total Cost (1A+1B+1C) | $694,623 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $694,623 |

2. Energy Savings (+) / Costs (-)

Date of NISTIR 85-3273-X used for Discount Factors Oct 1995

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $25. | /Mbtus | 3,297 | Mbtus | $82,293 | 14.47 | $1,190,781 |
| Elec. Deman | | | | | $0 | 13.47 | $0 |
| Distillate | $. | /Mbtus | 0 | Mbtus | $0 | 17.01 | $0 |
| Residual Oi | $. | /Mbtus | 0 | Mbtus | $0 | 17.23 | $0 |
| Natural Gas | $. | /Mbtus | 0 | Mbtus | $0 | 17.32 | $0 |
| Coal | $. | /Mbtus | 0 | Mbtus | $0 | 14.04 | $0 |
| LPG | $6.5 | /Mbtus | -906 | Mbtus | -$5,853 | 15.64 | -$91,537 |
| Solar | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Geothermal | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Biomass | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Refuse | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Wind | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Other | $7. | /Mbtus | 296 | Mbtus | $2,069 | 13.47 | $27,870 |
| TOTAL | | | 2,687 | Mbtus | $78,509 | | $1,127,114 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

| | |
|---|---|
| 4. First Year Dollar Savings | $78,509 |
| 5. Simple Payback Period (Years) | 8.85 |
| 6. Total Net Discounted Savings | $1,127,114 |
| 7. Savings to Investment Ratio | 1.62 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 6.65% |

Life Cycle Cost Analysis Study: HELSTF.LC
Energy Conservation Investment Program (ECIP) LCCID FY96
Installation & Location: WSMR
Region data: NEW Census Region: 4
Project NO. & Title: 03-0185.05 EEAP ENERGY STUDY - HELSTF FACILITY
Fiscal Year: 1997 Discrete Portion: ECO-F
Analysis Date: 08/16/96 Economic Life: 20 years
Prepared by: MICHAEL W. ELLIOTT, P.E., CEM

ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | 377038 |
| B. SIOH | 18794 |
| C. Design Cost | 19342 |
| D. Total Cost (1A+1B+1C) | $415,174 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $415,174 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1995

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $25. | /Mbtus | 2,324 | Mbtus | $58,007 | 14.47 | $839,362 |
| Elec. Deman | | | | | $0 | 13.47 | $0 |
| Distillate | $. | /Mbtus | 0 | Mbtus | $0 | 17.01 | $0 |
| Residual Oi | $. | /Mbtus | 0 | Mbtus | $0 | 17.23 | $0 |
| Natural Gas | $. | /Mbtus | 0 | Mbtus | $0 | 17.32 | $0 |
| Coal | $. | /Mbtus | 0 | Mbtus | $0 | 14.04 | $0 |
| LPG | $6.5 | /Mbtus | -906 | Mbtus | -$5,853 | 15.64 | -$91,537 |
| Solar | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Geothermal | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Biomass | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Refuse | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Wind | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Other | $7. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| TOTAL | | | 1,418 | Mbtus | $52,154 | | $747,825 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| Exist. Chlr. R | $30,800 | 1 | .96 | $29,587 |
| R-11 Pump Down | -$4,000 | 1 | .96 | -$3,842 |
| ONE TIME TOTAL | $26,800 | | | $25,744 |
| TOTAL | $26,800 | | | $25,744 |

| | |
|---|---|
| 4. First Year Dollar Savings | $53,494 |
| 5. Simple Payback Period (Years) | 7.77 |
| 6. Total Net Discounted Savings | $773,569 |
| 7. Savings to Investment Ratio<br>If < 1, Project does not qualify | 1.86 |
| 8. Adjusted Internal Rate of Return | 7.39% |

Life Cycle Cost Analysis — Study: HELSTF.LC

Energy Conservation Investment Program (ECIP) — LCCID FY96

Installation & Location: WSMR

Region data: NEW Census Region: 4

Project NO. & Title: 03-0185.05 EEAP ENERGY STUDY - HELSTF FACILITY

Fiscal Year: 1997 Discrete Portion: ECO-G

Analysis Date: 08/20/96 Economic Life: 20 years

Prepared by: Michael W. Elliott, P.E., CEM

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $226,028 |
| B. SIOH | $11,267 |
| C. Design Cost | $11,595 |
| D. Total Cost (1A+1B+1C) | $248,890 |
| E. Salvage Value of Existing Equip. | 0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $248,890 |

2. Energy Savings (+) / Costs (-)

Date of NISTIR 85-3273-X used for Discount Factors Oct 1995

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $25. | /Mbtus | 904 | Mbtus | $22,564 | 14.47 | $326,499 |
| Elec. Deman | | | | | $0 | 13.47 | $0 |
| Distillate | $. | /Mbtus | 0 | Mbtus | $0 | 17.01 | $0 |
| Residual Oi | $. | /Mbtus | 0 | Mbtus | $0 | 17.23 | $0 |
| Natural Gas | $. | /Mbtus | 0 | Mbtus | $0 | 17.32 | $0 |
| Coal | $. | /Mbtus | 0 | Mbtus | $0 | 14.04 | $0 |
| LPG | $6.5 | /Mbtus | 0 | Mbtus | $0 | 15.64 | $0 |
| Solar | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Geothermal | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Biomass | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Refuse | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Wind | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Other | $7. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| TOTAL | | | 904 | Mbtus | $22,564 | | $326,499 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| Exist. C | $70,000 | 1 | .96 | $67,243 |
| R-11 Pum | -$2,800 | 1 | .96 | -$2,690 |
| ONE TIME TOTAL | $67,200 | | | $64,553 |
| TOTAL | $67,200 | | | $64,553 |

| | |
|---|---|
| 4. First Year Dollar Savings | $25,924 |
| 5. Simple Payback Period (Years) | 9.65 |
| 6. Total Net Discounted Savings | $391,052 |
| 7. Savings to Investment Ratio | 1.57 |
| if < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 6.48% |

Life Cycle Cost Analysis — Study: HELSTF.LC

Energy Conservation Investment Program (ECIP) — LCCID FY96

Installation & Location: WSMR

Region data: NEW Census Region: 4

Project NO. & Title: 03-0185.05 EEAP ENERGY STUDY - HELSTF FACILITY

Fiscal Year: 1997 Discrete Portion: ECO-H

Analysis Date: 08/16/96 Economic Life: 20 years

Prepared by: MICHAEL W. ELLIOTT, P.E., CEM

## ECIP Summary Report

1. Investment

| | |
|---|---:|
| A. Construction Cost | 27752 |
| B. SIOH | 1383 |
| C. Design Cost | 1424 |
| D. Total Cost (1A+1B+1C) | $30,559 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $30,559 |

2. Energy Savings (+) / Costs (-)

Date of NISTIR 85-3273-X used for Discount Factors Oct 1995

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---:|---|---:|---|---:|---:|---:|
| Electricity | $25. | /Mbtus | 69 | Mbtus | $1,722 | 14.47 | $24,921 |
| Elec. Deman | | | | | $0 | 13.47 | $0 |
| Distillate | $. | /Mbtus | 0 | Mbtus | $0 | 17.01 | $0 |
| Residual Oi | $. | /Mbtus | 0 | Mbtus | $0 | 17.23 | $0 |
| Natural Gas | $. | /Mbtus | 0 | Mbtus | $0 | 17.32 | $0 |
| Coal | $. | /Mbtus | 0 | Mbtus | $0 | 14.04 | $0 |
| LPG | $6.5 | /Mbtus | 0 | Mbtus | $0 | 15.64 | $0 |
| Solar | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Geothermal | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Biomass | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Refuse | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Wind | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Other | $7. | /Mbtus | 296 | Mbtus | $2,069 | 13.47 | $27,870 |
| TOTAL | | | 365 | Mbtus | $3,791 | | $52,791 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---:|---|---|---:|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

| | |
|---|---:|
| 4. First Year Dollar Savings | $3,791 |
| 5. Simple Payback Period (Years) | 8.06 |
| 6. Total Net Discounted Savings | $52,791 |
| 7. Savings to Investment Ratio | 1.73 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 6.98% |

# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | | |
|---|---|---|---|
| **LOCATION:** HELSTF - LSTC | **PROJECT NO:** 03-0185.05 | | **DATE:** 8/20/96 |
| **ECO NO. F** | **BY :** KOTHMAN, K. | | **CHECKED BY:** HOWARD, D. |
| **PROJECT DESCRIPTION:** Chiller Retrofit | | | |

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE THE FOLLOWING : | | | | | | | | |
| CHILLER CH-1 YORK 177 TON R-11 | 1 | EA | 138 | 22.91 | $3,162 | | | $3,162 |
| CHILLER CH-2 YORK 265 TON R-11 | 1 | EA | 212 | 22.91 | $4,857 | | | $4,857 |
| CHILLER CH -3 YORK 156 TON R-11 | 1 | EA | 138 | 22.91 | $3,162 | | | $3,162 |
| HW BOILER B-1 DIESEL FIRED 5023 MBH | 1 | EA | 32 | 22.91 | $733 | | | $733 |
| HEATING WTR PUMP P-5 25 HP | 1 | EA | 6 | 22.91 | $137 | | | $137 |
| CHILLED WTR PUMP P-7 60 HP | 1 | EA | 14 | 22.91 | $321 | | | $321 |
| CHILLED WTR PUMP P-8 60 HP | 1 | EA | 14 | 22.91 | $321 | | | $321 |
| COND WTR PUMP P-10A 30 HP | 1 | EA | 7 | 22.91 | $160 | | | $160 |
| COND WTR PUMP P-10B 30 HP | 1 | EA | 7 | 22.91 | $160 | | | $160 |
| DUCT MNT REHEAT COIL LARGE 24X42 AVG DEMINSION | 17 | EA | 2.0 | 22.91 | $779 | | | $779 |
| DUCT MNT REHEAT COIL SMALL12X16 AVG DEMINSION | 22 | EA | 0.8 | 22.91 | $403 | | | $403 |
| ASBESTOS ABATEMENT OF EXISTING BOILER | 1 | JOB | 60.0 | 22.91 | $1,375 | 14,000.00 | $14,000 | $15,375 |
| SUBTOTAL FROM PAGE 2 | | | | | 31,584 | | 174,665 | 206,249 |
| SUBTOTAL FROM PAGE 3 | | | | | 7,487 | | 25,332 | 32,819 |
| | | | | SUBTOTAL | 54,641 | | 213,997 | 268,638 |
| | | | | O & P @ 20% | 10,928 | | 42,799 | 53,727 |
| | | | | SUBTOTAL | 65,569 | | 256,796 | 322,365 |
| | | | | DESIGN @ 6% | | | | 19,342 |
| | | | | SUBTOTAL | | | | 341,707 |
| | | | | SIOH @ 5.5% | | | | 18,794 |
| | | | | NMGRT @ 6% | | | | 20,502 |
| | | | | AREA ADJUST. @ 10% | | | | 34,171 |
| | | | | TOTAL | | | | $415,174 |

**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - LSTC

**PROJECT NO:** 03-0185.05 **DATE:** 8/20/96

**ECO NO.** F

**BY :** KOTHMAN, K. **CHECKED BY:** HOWARD, D.

**PROJECT DESCRIPTION:** Chiller Retrofit

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| INSTALL THE FOLLOWING : | | | | | | | | |
| CHILLER CH-1 (YORK) 50 TON R-22 | 1 | EA | 135 | 22.91 | $3,093 | 22,800.00 | $22,800 | $25,893 |
| CHILLER CH -2 (YORK) 180 TON R-123 | 1 | EA | 533 | 22.91 | $12,211 | 58,000.00 | $58,000 | $70,211 |
| CHILLER CH -3 (YORK) 180 TON R-123 | 1 | EA | 533 | 22.91 | $12,211 | 58,000.00 | $58,000 | $70,211 |
| HW BOILER B-1 (AERCO - PROPANE) 1000 MBH | 1 | EA | 34 | 22.91 | $779 | 13,850.00 | $13,850 | $14,629 |
| BOILER BREECHING - STAINLESS STEEL | 50 | LF | 0.9 | 22.91 | $1,031 | 147.00 | $7,350 | $8,381 |
| FLUE DRAFT ASSIST FAN, 250 CFM, APPROX. 1.0 IN. SP. | 1 | EA | 6.5 | 22.91 | $149 | 515.00 | $515 | $664 |
| HEATING WTR PUMP P-5 3/4 HP | 1 | EA | 5.18 | 22.91 | $119 | 800.00 | $800 | $919 |
| CHILLED WTR PUMP P-7A 5 HP | 1 | EA | 8.1 | 22.91 | $186 | 1,250.00 | $1,250 | $1,436 |
| CHILLED WTR PUMP P-7B 15 HP | 1 | EA | 14.4 | 22.91 | $330 | 2,350.00 | $2,350 | $2,680 |
| CHILLED WTR PUMP P-7C 15 HP | 1 | EA | 14.4 | 22.91 | $330 | 2,350.00 | $2,350 | $2,680 |
| COND WTR PUMP P-10A 10 HP | 1 | EA | 14.0 | 22.91 | $321 | 1,800.00 | $1,800 | $2,121 |
| COND WTR PUMP P-10B 20 HP | 1 | EA | 18.0 | 22.91 | $412 | 2,800.00 | $2,800 | $3,212 |
| COND WTR PUMP P-10C 20 HP | 1 | EA | 18.0 | 22.91 | $412 | 2,800.00 | $2,800 | $3,212 |
| SUBTOTAL PAGE 2 | | | | | 31,584 | | 174,665 | 206,249 |
| | | | | SUBTOTAL | | | | |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | NMGRT @ 6% | | | | |
| | | | | AREA ADJUST. @ 10% | | | | |
| | | | | TOTAL | | | | |


**HUITT-ZOLLARS, INC.**

**ENGINEERS / ARCHITECTS**

512 MAIN STREET, SUITE 1500

FORT WORTH, TEXAS 76102-3922

(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - LSTC

**PROJECT NO:** 03-0185.05 **DATE:** 8/20/96

**ECO NO.** F

**BY :** KOTHMAN, K. **CHECKED BY:** HOWARD, D.

**PROJECT DESCRIPTION:** Chiller Retrofit

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| INSTALL THE FOLLOWING : | | | | | | | | |
| DUCT MNT REHEAT COIL LARGE 24X42 AVG DEMINSION | 17 | EA | 5.9 | 22.91 | $2,298 | 822.00 | $13,974 | $16,272 |
| DUCT MNT REHEAT COIL SMALL12X16 AVG DEMINSION | 22 | EA | 3.5 | 22.91 | $1,764 | 176.50 | $3,883 | $5,647 |
| RECONNECT ELECTRICAL | 1 | JOB | 40 | 22.91 | $916 | 150.00 | $150 | $1,066 |
| INSTALL CHEMICAL SYSTEM | 1 | JOB | 16.0 | 22.91 | $367 | 1,500.00 | $1,500 | $1,867 |
| CONNECT TO EMS SYSTEM | 1 | JOB | 10.5 | 22.91 | $241 | 875.00 | $875 | $1,116 |
| TEST, BALANCE AND START-UP | 1 | JOB | 40 | 22.91 | $916 | | | $916 |
| REFRIGERANT DETECTION SYSTEM AND VENTILATION | 1 | JOB | 41.0 | 22.91 | 939 | 4,100.00 | 4,100 | $5,039 |
| PROPANE GAS DETECTION SYSTEM AND ALARM | 1 | JOB | 2.0 | 22.91 | 46 | 850.00 | 850 | $896 |
| SUBTOTAL PAGE 3 | | | | | 7,487 | | 25,332 | 32,819 |
| | | | | SUBTOTAL | | | | |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | NMGRT @ 6% | | | | |
| | | | | AREA ADJUST. @ 10% | | | | |
| | | | | TOTAL | | | | |


**HUITT-ZOLLARS, INC.**

**ENGINEERS / ARCHITECTS**

512 MAIN STREET, SUITE 1500

FORT WORTH, TEXAS 76102-3922

(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

| | | | |
|---|---|---|---|
| **LOCATION:** HELSTF - Test Cell 2 | **PROJECT NO:** 03-0185.05 | | **DATE:** 8/20/96 |
| **ECO NO. G** | **BY :** KOTHMAN, K. | | **CHECKED BY:** HOWARD, D. |

**PROJECT DESCRIPTION:** Chiller Retrofit

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE THE FOLLOWING: | | | | | | | | |
| CHILLER CH-51 180 TON R-123 | 2 | EA | 133 | 22.91 | $6,094 | | | $6,094 |
| INSTALL THE FOLLOWING: | | | | | | | | |
| CHILLER CH-51 180 TON R-123 | 2 | EA | 533 | 22.91 | $24,422 | 58,000.00 | $116,000 | $140,422 |
| CONDENSER WTR PUMP 15 HP | 2 | EA | 14 | 22.91 | $641 | 2,350.00 | $4,700 | $5,341 |
| EXTEND PIPE MANIFOLD | 1 | LS | 30 | 22.91 | $687 | 1,200.00 | $1,200 | $1,887 |
| ELECTRICAL FEEDERS AND STARTERS | 1 | EA | 41 | 24.64 | $1,010 | 1,250.00 | $1,250 | $2,260 |
| REFRIGERANT DETECTION SYSTEM AND VENTILATION | 1 | JOB | 41.0 | 22.91 | 939 | 4,100.00 | 4,100 | $5,039 |
| | | | | SUBTOTAL | 33,793 | | 127,250 | 161,043 |
| | | | | O & P @ 20% | 6,759 | | 25,450 | 32,209 |
| | | | | SUBTOTAL | 40,552 | | 152,700 | 193,252 |
| | | | | DESIGN @ 6% | | | | 11,595 |
| | | | | SUBTOTAL | | | | 204,847 |
| | | | | SIOH @ 5.5% | | | | 11,267 |
| | | | | NMGRT @ 6% | | | | 12,291 |
| | | | | AREA ADJUST. @ 10% | | | | 20,485 |
| | | | | TOTAL | | | | $248,890 |


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FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - Test Cell 2
**PROJECT NO:** 03-0185.05
**DATE:** 8/20/96

**ECO NO. H**
**BY :** KOTHMAN, K.
**CHECKED BY:** HOWARD, D.

**PROJECT DESCRIPTION:** Boiler Retrofit

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE THE FOLLOWING: | | | | | | | | |
| EXISTING BOILER, HEAT EXCHANGER, AND PRIMARY PUMPS | 1 | JOB | 80 | 22.91 | $1,833 | 2,500.00 | $2,500 | $4,333 |
| ELECTRICAL DEMOLITION | 1 | EA | 3.5 | 24.64 | $86 | 25.00 | $25 | $111 |
| INSTALL THE FOLLOWING: | | | | | | | | |
| NEW BOILER OIL FIRED 1200 MBH-OUT | 1 | EA | 50 | 22.91 | $1,146 | 10,000.00 | $10,000 | $11,146 |
| NEW BOILER BEACHING | 1 | LS | 20 | 22.91 | $458 | 800.00 | $800 | $1,258 |
| EXTEND PIPE MANIFOLD | 1 | LS | 35 | 22.91 | $802 | 1,150.00 | $1,150 | $1,952 |
| POLYPROPYLENE GLYCOL REPLACEMENT | 1 | JOB | 25 | 22.91 | $573 | 400.00 | $400 | $973 |
| | | | | SUBTOTAL | 4,898 | | 14,875 | 19,773 |
| | | | | O & P @ 20% | 980 | | 2,975 | 3,955 |
| | | | | SUBTOTAL | 5,878 | | 17,850 | 23,728 |
| | | | | DESIGN @ 6% | | | | 1,424 |
| | | | | SUBTOTAL | | | | 25,152 |
| | | | | SIOH @ 5.5% | | | | 1,383 |
| | | | | NMGRT @ 6% | | | | 1,509 |
| | | | | AREA ADJUST. @ 10% | | | | 2,515 |
| | | | | TOTAL | | | | $30,559 |


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APPENDIX A
ENERGY COST ANALYSIS

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APPENDIX A
ENERGY COST ANALYSIS

A. Electrical Energy Cost Analysis

*Electric Rate Schedule:* White Sands Missile Range (WSMR), including all of its tenants, is supplied electrical power by the El Paso Electric Company (EPEC). The EPEC bills the base for it's entire demand and usage, even though some of the tenants such as HELSTF are separately metered. WSMR, in turn, bills each of the tenants according to a blended (melded) rate. For HELSTF, the rate is \$0.0821/KWH. This rate appears approximately twice as much as the rates of \$19.00/KW and \$0.008/KWH charged WSMR from the EPEC. A portion of this cost includes transmission and administrative costs, but HELSTF should research the possibility of being billed directly from the EPEC, especially since 80% of the consumption for the facility is already metered (LSTC Building).

*Avoided Costs:* In order to convert electric demand and energy savings into dollar savings, the avoided costs of demand and energy are determined. These are the marginal cost savings to be realized by the facility, per unit of demand or energy saved. Using the above billing information, the *Avoided Cost of Energy* ($C_E$) is determined as follows:

$$C_E = (\ E\ )\ x\ \frac{KWH}{3413\ BTU}\ x\ \frac{1{,}000{,}000\ BTU}{MMBTU} = \frac{\$}{MMBTU}$$

where,

E = melded rate energy charge = \$0.0821/KWH

$$C_E = (0.0821)\ x\ \frac{1{,}000{,}000}{3413} = \frac{\$24.06}{MMBTU}$$

*Rebate Program:* The EPEC may offer cash incentives for some energy conservation retrofits in the future, but specific rebates were not available at the time of this study. The facility should consult EPEC for information on possible future rebate opportunities, prior to the implementation of the ECOs.

B. Diesel and Propane Fuel Cost Analysis

The WSMR is currently supplied diesel and propane fuel by local suppliers at individual storage tanks throughout the range, including those used by the HELSTF facility. These fuel suppliers bill the Army for fuel deliveries, and the Army passes on the cost to HELSTF for the fuel that they use. There is no cost markup by the Army on diesel and propane fuel. The current billing rate for diesel and propane fuel is as follows:

Diesel Fuel Rate: \$0.970/gallon

Propane Fuel Rate: \$0.676/gallon

Using these rates, the Avoided Cost of Diesel ($C_D$) and the Avoided Cost of Propane ($C_P$) which are used in all life cycle cost analysis calculations in this study are as follows:

$$C_D = \frac{\$0.970}{gallon} \; x \; \frac{5.825 \; gallon}{MMBTU} = \frac{\$5.65}{MMBTU}$$

Conflict [illegible] in Figure 1. [illegible] [illegible] Diesel [illegible] heat value [illegible] approx 138,[illegible] BTU/Gal, or 1,000,[illegible] [illegible] = 7.21 Gal/MMBTU.

This is consistent with annual usage shown in Fig 1.

$$C_P = \frac{\$0.676}{gallon} \; x \; \frac{9.55 \; gallon}{MMBTU} = \frac{\$6.46}{MMBTU}$$

APPENDIX B
RECOMMENDED ECO CALCULATIONS

TABLE OF CONTENTS

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | A |
| DATE: | 5/6/96 |
| ECO TITLE: | Install Electronic Ballasts and Energy Savings Fluorescent Lamps, Compact Fluorescent Lamps in Incandescent Fixtures, and Upgrade Exit Lights with LED Kits |
| INSTALLATION: | HELSTF |
| LOCATION: | White Sands Missile Range, New Mexico |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 2,016 | MMBTU/yr |
| Diesel Energy Savings | -31 | MMBTU/yr |
| Total Energy Savings | 1,985 | MMBTU/yr |
| Total Cost Savings | 50,103 | $/yr |
| Total Investment | 179,176 | $ |
| Simple Payback | 3.58 | yrs |
| SIR | 4.05 | |

B. ECO Description:

Replace all of the existing magnetic ballasts and the T12 lamps in all 4' fluorescent light fixtures with new electronic ballasts and T8 lamps. This will require the replacement of existing lamp sockets with new sockets designed for the T8 lamps. The existing F40T12 lamps (40 watts) should be replaced with F32T8 lamps (32 watts). There is a total of 1,796 ballasts to be retrofitted, and 3,533 lamps to be retrofitted.

Replace all incandescent lamps in existing fixtures with new compact fluorescent lamps. This will require an electronic ballast adaptor base which screws into the existing lamp socket of the fixture. The existing 100 watt to 200 watt incandescent lamps should be replaced with CF26DD lamps (26 watts). There is a total of 37 fixtures to be retrofitted.

Replace all incandescent lamps in existing exit lights with new LED retrofit kits. The kits connect to the existing incandescent lamp sockets. The 20 watt lamps (2 in each exit light) should be replaced with LED light strips (1.8 watts). There is a total of 37 exit lights to be retrofitted.

This ECO will require a design specification of the new equipment and scope of work, as well as the replacement of fluorescent ballasts and lamps.

C. Discussion:

The existing 4' fluorescent fixtures in the LSTC and TC-1 buildings currently use 4' 40 watt standard T12 lamps. The newer technology T8 lamps can produce an equivalent or higher lumen output, with a lower power input. Also, all of the existing fixtures have standard magnetic ballasts. Due to the advanced technology of electronic ballasts over magnetic ballast technology, each light fixture retrofit will only require one electronic ballast. In the past, three lamp and four lamp fixtures required two, magnetic ballasts since magnetic ballasts were only available in one lamp and two lamp versions. Electronic ballasts are available in one lamp, two lamp, three lamp, and four lamp versions. The advanced technology electronic ballasts operate on a higher frequency than the magnetic type, and are therefore more efficient, requiring less input power.

The existing incandescent light fixtures in the LSTC and TC-1 buildings currently use standard 100, 150 and 200 watt incandescent lamps. The newer technology compact fluorescent lamps can produce an equivalent or higher lumen output, with a lower power input.

The existing exit lights in the LSTC and TC-1 buildings use two 20 watt incandescent lamps each. The newer technology LED lamps can produce an equivalent lumen output across the face of the exit sign, with a lower power input.

Since this retrofit will reduce the building lighting load, there will be a savings in HVAC cooling energy, and a penalty in heating energy.

D. Savings Calculations:

The monthly peak demand and energy consumption of the existing lighting systems were calculated using the Trace 600 computer program.[1] LSTC and TC-1 existing lighting systems were modeled by the computer to provide a realistic energy usage profile. Field data obtained from the buildings were used to create these computer building models.[2]

The monthly peak demand and energy consumption of the proposed lighting systems were calculated using the Trace 600 computer program. LSTC and TC-1 proposed lighting systems were input and modeled by the computer to provide a new energy usage profile. Equipment lists of the proposed lighting systems, used to create these computer building models, are shown on pages B-3 to B-27.

Once the computer simulations were completed, the total annual demand costs and energy consumptions of the existing and proposed lighting systems were compared to determine the annual savings from this ECO. These savings calculations are shown on pages B-28 to B-31.

E. Cost Estimate

The total implementation costs for this ECO were estimated on page B-32. Manufacturers data on retrofit products which were used to produce this estimate can be found in Appendix E (Volume II, Tab 5).

F. Life Cycle Cost Analysis.

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. The summary sheet for the life cycle cost analysis is shown on page B-33. The "Other" fuel type shown in Section # 2 is for diesel fuel consumption. The results of the analysis are listed in the summary on page B-1.

## REFERENCES

1. See Appendix G, (Volume II, Tab 7) for computer model input assumptions and data, and energy consumption output data.

2. See Appendix F (Volume II, Tab 6) for building field data and existing lighting system data.

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Stairs - East and West | 18 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breakers | 1,116 W | 24 | 7 | 52 | 9,749 | |
| Communications - B-8 | 34 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breakers | 2,108 W | 24 | 7 | 52 | 18,415 | |
| Mech. Room - B-27 | 31 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breakers | 1,922 W | 24 | 7 | 52 | 16,791 | |
| Battery Room - B-29 | 4 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Local Switch | 112 W | 24 | 7 | 52 | 978 | |
| Corridor - B-1 | 9 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breakers | 558 W | 24 | 7 | 52 | 4,875 | |
| Janitor Supplies / Break Room - B-18 | 12 | Electronic Ballast and 3-FO32/T8 Lamps | 90 W | Local Switches | 1,080 W | 24 | 7 | 52 | 9,435 | |
| Elec/HVAC Control Room - B-32 | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | 372 W | 24 | 7 | 52 | 3,250 | |
| Janitor Closet | 1 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Local Switch | 28 W | 24 | 7 | 52 | 245 | |
| Restroom | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 62 W | 24 | 7 | 52 | 542 | |
| AHU Vestibule | 11 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breakers | 682 W | 24 | 7 | 52 | 5,958 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | | CONTROL | AREA LOAD | | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Magnetic Tape Storage - B-18 | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Local Switch | 372 | W | 24 | 7 | 52 | 3,250 | |
| Aerobics Room | 10 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Local Switch | 620 | W | 24 | 7 | 52 | 5,416 | |
| Men's Restroom | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Local Switch | 186 | W | 24 | 7 | 52 | 1,625 | |
| Women's Restroom | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Local Switch | 186 | W | 24 | 7 | 52 | 1,625 | |
| Vestibule | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Breaker | 62 | W | 24 | 7 | 52 | 542 | |
| Office | 2 | Electronic Ballast and 3-FO32/T8 Lamps | 90 | W | Local Switch | 180 | W | 9 | 5 | 52 | 421 | |
| Library | 23 | Electronic Ballast and 3-FO32/T8 Lamps | 90 | W | Local Switch | 2,070 | W | 24 | 7 | 52 | 18,084 | |
| Office - B-17B | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Local Switch | 124 | W | 9 | 5 | 52 | 290 | |
| Corridor - B-3 | 12 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Breakers | 744 | W | 24 | 7 | 52 | 6,500 | |
| Corridor - B-2 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Breakers | 248 | W | 24 | 7 | 52 | 2,167 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| I&C Electrical Shop - B-17D | 24 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | 1,488 W | 24 | 7 | 52 | 12,999 | |
| Office - B-17C | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 9 | 5 | 52 | 534 | |
| Storage - B-19 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 24 | 7 | 52 | 2,167 | |
| Storage - B-20 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 24 | 7 | 52 | 2,167 | |
| Storage - B-21 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 24 | 7 | 52 | 2,167 | |
| Vestibule | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | 124 W | 24 | 7 | 52 | 1,083 | |
| Vestibule - B-5 | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 124 W | 24 | 7 | 52 | 1,083 | |
| Air Duct - B-30 | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 186 W | 24 | 7 | 52 | 1,625 | |
| Break Room - B-12 | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 372 W | 24 | 7 | 52 | 3,250 | |
| Kitchen - B-12A | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 186 W | 24 | 7 | 52 | 1,625 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Conference - B-13 | 1 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 114 W | 24 | 7 | 52 | 996 | |
| Electrical Equipment - B-24 | 14 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breakers | 868 W | 24 | 7 | 52 | 7,583 | |
| Fallout Shelter Supply - B-22 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 24 | 7 | 52 | 2,167 | |
| Hughes - B-9 | 6 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 684 W | 24 | 7 | 52 | 5,975 | |
| Hughes O&M Test Cell B Group - B-10 | 12 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switches | 1,368 W | 24 | 7 | 52 | 11,951 | |
| Hughes O&M Camera Lab - B-11 | 18 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switches | 2,052 W | 24 | 7 | 52 | 17,926 | |
| Corridor - B-4 | 15 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breakers | 930 W | 24 | 7 | 52 | 8,124 | |
| Hughes SLBD Optics Lab | 32 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | 1,984 W | 24 | 7 | 52 | 17,332 | |
| Equipment Room - B-28 | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 186 W | 24 | 7 | 52 | 1,625 | |
| US Navy Library - B-11A | 6 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 684 W | 24 | 7 | 52 | 5,975 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Vestibule - B-4A | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | 248 W | 24 | 7 | 52 | 2,167 | |
| Boiler Room - B-26 | 5 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 310 W | 24 | 7 | 52 | 2,708 | |
| Storage - B-25 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 24 | 7 | 52 | 2,167 | |
| Storage - B-25A | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 124 W | 24 | 7 | 52 | 1,083 | |
| Basement Mezzanine | 9 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 558 W | 24 | 7 | 52 | 4,875 | |
| Vestibule - 102 | 1 | Electronic Ballast and 1-FO32/T8 Lamps | 38 W | Breaker | 38 W | 24 | 7 | 52 | 332 | |
| Closet - 105 | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 62 W | 24 | 7 | 52 | 542 | |
| Office - 105A | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 9 | 5 | 52 | 580 | |
| Reception - 105 | 11 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 682 W | 24 | 7 | 52 | 5,958 | |
| Office - 105B | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 9 | 5 | 52 | 580 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC
ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Office - 105C | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 9 | 5 | 52 | 580 | |
| Office - 105F | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 372 W | 9 | 5 | 52 | 870 | |
| Office - 105E | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 9 | 5 | 52 | 580 | |
| Office - 105D | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 9 | 5 | 52 | 580 | |
| Office - 107A | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 24 | 7 | 52 | 2,167 | |
| Office - 107C | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 9 | 5 | 52 | 580 | |
| Office - 107 | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 124 W | 24 | 7 | 52 | 1,083 | |
| Vault - 107B | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 124 W | 24 | 7 | 52 | 1,083 | |
| Janitor | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 62 W | 24 | 7 | 52 | 542 | |
| Corridor - 112 | 16 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | 992 W | 24 | 7 | 52 | 8,666 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Corridor - 104 | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | 124 W | 24 | 7 | 52 | 1,083 | |
| Women's Restroom | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 124 W | 24 | 7 | 52 | 1,083 | |
| Men's Restroom | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 124 W | 24 | 7 | 52 | 1,083 | |
| Women's Restroom | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 186 W | 24 | 7 | 52 | 1,625 | |
| Cable/Power Terminals | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 124 W | 24 | 7 | 52 | 1,083 | |
| I & C shop - 119 | 28 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | 1,736 W | 24 | 7 | 52 | 15,166 | |
| Test Cell 4 Control Room - 119A | 28 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switches | 3,192 W | 24 | 7 | 52 | 27,885 | |
| Cable Transition Room - 119B | 8 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 496 W | 24 | 7 | 52 | 4,333 | |
| Observation - 121 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 24 | 7 | 52 | 2,167 | |
| Site control Room - 123 | 21 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | 1,302 W | 24 | 7 | 52 | 11,374 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Site Control Office - 123A | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 124 W | 9 | 5 | 52 | 290 | |
| Vestibule | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 62 W | 24 | 7 | 52 | 542 | |
| Observation - 125 | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 186 W | 24 | 7 | 52 | 1,625 | |
| Corridor - 124 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 24 | 7 | 52 | 2,167 | |
| | 4 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 456 W | 24 | 7 | 52 | 3,984 | |
| Auxiliary Control Room - 128 | 20 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switches | 2,280 W | 24 | 7 | 52 | 19,918 | |
| Operational Controllers Computer Room - 127A | 24 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | 1,488 W | 24 | 7 | 52 | 12,999 | |
| MTIR & Vacuum Chamber control Room - 127 | 31 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | 1,922 W | 24 | 7 | 52 | 16,791 | |
| Cable/Power Terminals | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 124 W | 24 | 7 | 52 | 1,083 | |
| Office - 135 | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 124 W | 9 | 5 | 52 | 290 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Conference Room - 135A | 5 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 310 W | 24 | 7 | 52 | 2,708 | |
| Office - 137A | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 9 | 5 | 52 | 534 | |
| Office - 137B | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 9 | 5 | 52 | 534 | |
| Office - 137C | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 9 | 5 | 52 | 534 | |
| Office - 137D | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 9 | 5 | 52 | 534 | |
| Office - 137E | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 9 | 5 | 52 | 534 | |
| Office - 137F | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 9 | 5 | 52 | 534 | |
| Office - 137G | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 9 | 5 | 52 | 534 | |
| Corridor & Coffee Room - 137H | 7 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 434 W | 24 | 7 | 52 | 3,791 | |
| Projection Room - 139 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 24 | 7 | 52 | 1,992 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Conference Room "A" - 141 | 12 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 744 W | 24 | 7 | 52 | 6,500 | |
| Office - 147C | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 124 W | 9 | 5 | 52 | 290 | |
| Office - 147 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 9 | 5 | 52 | 580 | |
| Office - 147A | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 9 | 5 | 52 | 580 | |
| Office - 147B | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 9 | 5 | 52 | 580 | |
| Corridor - 150 | 8 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | 496 W | 24 | 7 | 52 | 4,333 | |
| Office - 149 | 8 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 496 W | 9 | 5 | 52 | 1,161 | |
| Office - 149A | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 9 | 5 | 52 | 580 | |
| Office - 149B | 4 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 456 W | 9 | 5 | 52 | 1,067 | |
| Office - 151 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 9 | 5 | 52 | 580 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Office - 153 | 8 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 496 W | 9 | 5 | 52 | 1,161 | |
| Office - 153A | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 9 | 5 | 52 | 534 | |
| Office - 153B | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 9 | 5 | 52 | 534 | |
| Conference Room "B" - 155 | 8 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 912 W | 24 | 7 | 52 | 7,967 | |
| Electrical Chase - 106A | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 124 W | 24 | 7 | 52 | 1,083 | |
| Communication Room - 106B | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 62 W | 24 | 7 | 52 | 542 | |
| Office - 106 | 8 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 496 W | 9 | 5 | 52 | 1,161 | |
| Vestibule - 108 | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | 62 W | 24 | 7 | 52 | 542 | |
| Observation Room - 159 | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 186 W | 24 | 7 | 52 | 1,625 | |
| User's Control Room - 110 | 23 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | 1,426 W | 24 | 7 | 52 | 12,458 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| CCTV Equipment Room - 116 | 18 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | 1,116 W | 24 | 7 | 52 | 9,749 | |
| Timing Station Room - 116A | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 24 | 7 | 52 | 2,167 | |
| Office - 120 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 24 | 7 | 52 | 2,167 | |
| MET Room - 120A | 12 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switches | 1,368 W | 24 | 7 | 52 | 11,951 | |
| Data Processing Computer Room - 122 | 21 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switches | 2,394 W | 24 | 7 | 52 | 20,914 | |
| HELDPS Break Room | 8 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 496 W | 24 | 7 | 52 | 4,333 | |
| Tape Library | 8 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 496 W | 24 | 7 | 52 | 4,333 | |
| Telemetry Room - 148A | 15 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switches | 1,710 W | 24 | 7 | 52 | 14,939 | |
| Office 148 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 24 | 7 | 52 | 2,167 | |
| Office 148B | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 124 W | 9 | 5 | 52 | 290 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | | CONTROL | AREA LOAD | | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Image Analysis Room - 146A | 10 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Local Switches | 620 | W | 24 | 7 | 52 | 5,416 | |
| Storage - 146B | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Local Switch | 62 | W | 24 | 7 | 52 | 542 | |
| Office - 146 | 5 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Local Switch | 310 | W | 24 | 7 | 52 | 2,708 | |
| Corridor - 157 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Breaker | 248 | W | 24 | 7 | 52 | 2,167 | |
| | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Breaker | 186 | W | 24 | 7 | 52 | 1,625 | |
| Office - 157 | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Local Switch | 62 | W | 9 | 5 | 52 | 145 | |
| Office - 156 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 | W | Local Switch | 228 | W | 9 | 5 | 52 | 534 | |
| Storage - 156A | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Local Switch | 62 | W | 24 | 7 | 52 | 542 | |
| Main Stairs - 201 | 5 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Breaker | 310 | W | 24 | 7 | 52 | 2,708 | |
| East Stairs - 209 | 5 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Breaker | 310 | W | 24 | 7 | 52 | 2,708 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Corridor - 203 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 24 | 7 | 52 | 2,167 | |
| Storage - 225 | 1 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Local Switch | 28 W | 24 | 7 | 52 | 245 | |
| Computer Room - 205 | 3 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 342 W | 24 | 7 | 52 | 2,988 | |
| Test Cell #3 Control - 206 | 22 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | 1,364 W | 24 | 7 | 52 | 11,916 | |
| Office - 206A | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 186 W | 24 | 7 | 52 | 1,625 | |
| Office - 206B | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 24 | 7 | 52 | 2,167 | |
| Test Cell #3A Instrumentaion - 204 | 22 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | 1,364 W | 24 | 7 | 52 | 11,916 | |
| Office - 206C | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 124 W | 24 | 7 | 52 | 1,083 | |
| Test Cell #3B Instrumentaion - 207 | 26 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | 1,612 W | 24 | 7 | 52 | 14,082 | |
| Storage - 208 | 1 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Local Switch | 28 W | 24 | 7 | 52 | 245 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Corridor - 232 | 10 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | 620 W | 24 | 7 | 52 | 5,416 | |
| Office - 210 | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 372 W | 9 | 5 | 52 | 870 | |
| Office - 210A | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 372 W | 9 | 5 | 52 | 870 | |
| Office - 211 | 7 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 798 W | 9 | 5 | 52 | 1,867 | |
| Office - 211A | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 372 W | 9 | 5 | 52 | 870 | |
| Reception - 212 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 9 | 5 | 52 | 534 | |
| Office - 212A | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 9 | 5 | 52 | 580 | |
| Office - 212B | 5 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 310 W | 9 | 5 | 52 | 725 | |
| Office - 212C | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 9 | 5 | 52 | 534 | |
| Office - 213 | 5 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 310 W | 9 | 5 | 52 | 725 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Office - 215 | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 186 W | 9 | 5 | 52 | 435 | |
| Janitor - 214 | 1 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Local Switch | 28 W | 24 | 7 | 52 | 245 | |
| Office - 217 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 9 | 5 | 52 | 580 | |
| Mens Restroom - 216 | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 124 W | 24 | 7 | 52 | 1,083 | |
| Womens Restroom - 218 | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 62 W | 24 | 7 | 52 | 542 | |
| Office - 219 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 9 | 5 | 52 | 534 | |
| Office - 221 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 9 | 5 | 52 | 534 | |
| Office - 222 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 9 | 5 | 52 | 534 | |
| Office - 220 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 9 | 5 | 52 | 534 | |
| Corridor - 300 | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | 372 W | 24 | 7 | 52 | 3,250 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Copy Room - 308 | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 62 W | 24 | 7 | 52 | 542 | |
| Office - 312 | 4 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 456 W | 24 | 7 | 52 | 3,984 | |
| Office - 309 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 24 | 7 | 52 | 1,992 | |
| Office - 307 | 5 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 310 W | 24 | 7 | 52 | 2,708 | |
| Office - 305 | 4 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 456 W | 24 | 7 | 52 | 3,984 | |
| Office - 304 | 3 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 342 W | 24 | 7 | 52 | 2,988 | |
| VAX - 301 | 30 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switches | 3,420 W | 24 | 7 | 52 | 29,877 | |
| Office - 306 | 4 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 456 W | 24 | 7 | 52 | 3,984 | |
| Office - 303 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 24 | 7 | 52 | 1,992 | |
| Office - 302 | 4 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 456 W | 24 | 7 | 52 | 3,984 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Office - 310 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 24 | 7 | 52 | 1,992 | |
| Office - 311 | 9 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switches | 1,026 W | 24 | 7 | 52 | 8,963 | |
| Office - 313 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 228 W | 24 | 7 | 52 | 1,992 | |
| Office - 314 | 3 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 342 W | 24 | 7 | 52 | 2,988 | |
| Office - 315 | 1 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 114 W | 24 | 7 | 52 | 996 | |
| Stairs - 223 | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | 186 W | 24 | 7 | 52 | 1,625 | |
| Corridor - 230 | 12 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | 744 W | 24 | 7 | 52 | 6,500 | |
| Office - 230A | 5 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | 310 W | 24 | 7 | 52 | 2,708 | |
| Office - 230B | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | 248 W | 24 | 7 | 52 | 2,167 | |
| Office - 230C | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | 186 W | 24 | 7 | 52 | 1,625 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Office - 230D | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | 186 W | 24 | 7 | 52 | 1,625 | |
| Office - 230E | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | 248 W | 24 | 7 | 52 | 2,167 | |
| Office - 230F | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | 186 W | 24 | 7 | 52 | 1,625 | |
| Office - 230G | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | 186 W | 24 | 7 | 52 | 1,625 | |
| Office - 230H | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | 186 W | 24 | 7 | 52 | 1,625 | |
| Office - 230I | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | 186 W | 24 | 7 | 52 | 1,625 | |
| Office - 230J | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | 186 W | 24 | 7 | 52 | 1,625 | |
| Storage - 330 | 19 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 1,178 W | 24 | 7 | 52 | 10,291 | |
| Stair - 224 | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | 186 W | 24 | 7 | 52 | 1,625 | |
| Corridor - 231 | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | 186 W | 24 | 7 | 52 | 1,625 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Office - 231A | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 372 W | 24 | 7 | 52 | 3,250 | |
| Office - 231B | 23 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 1,426 W | 24 | 7 | 52 | 12,458 | |
| Microvax - 231C | 16 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 992 W | 24 | 7 | 52 | 8,666 | |
| Exits | 15 | LED Retrofit Kit 1-1.8 Watt Unit | 1.8 W | Breaker | 27 W | 24 | 7 | 52 | 236 | |
| TOTAL ENERGY USE | | | | | 94,033 W | | | | 738,353 | 0 |

PROPOSED RETROFIT LIST FOR: HELSTF - TEST CELL 1

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| North Optics Room - 101 | 45 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | 2,790 W | 24 | 7 | 52 | 24,373 | |
| South Optics Room - 102 | 30 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | 1,860 W | 24 | 7 | 52 | 16,249 | |
| | 2 | NO CHANGE | 200 W | Local Switch | 400 W | 24 | 7 | 52 | 3,494 | |
| ETA Control Room - 103 | 9 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 558 W | 24 | 7 | 52 | 4,875 | |
| Storage - 104 | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 62 W | 24 | 7 | 52 | 542 | |
| Vestibule - 105 | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 62 W | 24 | 7 | 52 | 542 | |
| Vestibule - 101 | 1 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Local Switch | 28 W | 24 | 7 | 52 | 245 | |
| Optics Room - 102 | 12 | NO CHANGE | 460 W | Breakers | 5,520 W | 24 | 7 | 52 | 48,223 | |
| | 6 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Breakers | 168 W | 24 | 7 | 52 | 1,468 | |
| Vestibule - 103 | 1 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Breaker | 28 W | 24 | 7 | 52 | 245 | |

PROPOSED RETROFIT LIST FOR: HELSTF - TEST CELL 1
ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Device Room - 104 | 30 | NO CHANGE | 460 W | Breakers | 13,800 W | 24 | 7 | 52 | 120,557 | |
| | 6 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Breaker | 168 W | 24 | 7 | 52 | 1,468 | |
| Local Loop Electronics Room - 104A | 10 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switches | 1,140 W | 24 | 7 | 52 | 9,959 | |
| BTA Room - 105 | 16 | NO CHANGE | 460 W | Breakers | 7,360 W | 24 | 7 | 52 | 64,297 | |
| | 2 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Breaker | 56 W | 24 | 7 | 52 | 489 | |
| Vestibule - 106 | 1 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Breaker | 28 W | 24 | 7 | 52 | 245 | |
| PT Service Room - 107 | 4 | NO CHANGE | 300 W | Local Switch | 1,200 W | 24 | 7 | 52 | 10,483 | |
| | 1 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | | 28 W | 24 | 7 | 52 | 245 | |
| Mechanical Equipment-108 | 2 | NO CHANGE | 300 W | Local Switch | 600 W | 24 | 7 | 52 | 5,242 | |
| | 1 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | | 28 W | 24 | 7 | 52 | 245 | |

PROPOSED RETROFIT LIST FOR: HELSTF - TEST CELL 1
ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Optics Electronics Room - 109 | 21 | Electronic Ballast and 3-FO32/T8 Lamps | 90 W | Local Switch | 1,890 W | 24 | 7 | 52 | 16,511 | |
| | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 248 W | 24 | 7 | 52 | 2,167 | |
| Elevator Vestibule - 110 | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 124 W | 24 | 7 | 52 | 1,083 | |
| Stairs | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | 372 W | 24 | 7 | 52 | 3,250 | |
| Electronics Equipment Room - 201 | 6 | NO CHANGE | 300 W | Local Switches | 1,800 W | 24 | 7 | 52 | 15,725 | |
| | 2 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Local Switch | 56 W | 24 | 7 | 52 | 489 | |
| Mechanical Room - 203 | 4 | NO CHANGE | 300 W | Local Switch | 1,200 W | 24 | 7 | 52 | 10,483 | |
| | 2 | NO CHANGE | 460 W | Local Switch | 920 W | 24 | 7 | 52 | 8,037 | |
| | 4 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Local Switch | 112 W | 24 | 7 | 52 | 978 | |
| P.T. Tower - | 10 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 620 W | 24 | 7 | 52 | 5,416 | |

PROPOSED RETROFIT LIST FOR: HELSTF - TEST CELL 1

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| 204 | 4 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Local Switch | 112 W | 24 | 7 | 52 | 978 | |
| Elevator Vestibule - 205 | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 124 W | 24 | 7 | 52 | 1,083 | |
| P.T. Tower - 301 | 12 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 744 W | 24 | 7 | 52 | 6,500 | |
| Elevator Vestibule - 302 | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 124 W | 24 | 7 | 52 | 1,083 | |
| P.T. Tower - 401 | 11 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 682 W | 24 | 7 | 52 | 5,958 | |
| Elevator Vestibule - 402 | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | 124 W | 24 | 7 | 52 | 1,083 | |
| HPOC Enclosure | 4 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | 456 W | 24 | 7 | 52 | 3,984 | |
| P.T. Tower - 501 | 4 | NO CHANGE | 460 W | Local Switch | 1,840 W | 24 | 7 | 52 | 16,074 | |
| Building Exterior | 6 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Photocell | 168 W | 12 | 7 | 52 | 734 | |
| Building Exterior | 11 | NO CHANGE | 200 W | Photocell | 2,200 W | 12 | 7 | 52 | 9,610 | |

PROPOSED RETROFIT LIST FOR: HELSTF - TEST CELL 1

ECO No. A: Install Electronic Ballasts and Energy Saving Lamps

| AREA SERVED | QTY. | RETROFIT DESCRIPTION | FIXTURE LOAD | CONTROL | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Building Exterior | 6 | NO CHANGE | 95 W | Photocell | 570 W | 12 | 7 | 52 | 2,490 | |
| Exits | 22 | LED Retrofit Kit 1-1.8 Watt Unit | 1.8 W | Breaker | 40 W | 24 | 7 | 52 | 349 | |
| TOTAL ENERGY USE | | | | | 50,410 W | | | | 427,551 | 0 |

| ITEM | ECO-A LSTC BUILDING, EXISTING LIGHTING & HVAC SYSTEMS MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 151.4 | 151.4 | 151.4 | 151.4 | 151.4 | 151.4 | 151.4 | 151.4 | 151.4 | 151.4 | 151.4 | 151.4 | 1,188,832 | |
| Chiller CH-1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 771,420 | |
| Chiller CH-3 | 54.9 | 62.8 | 66.2 | 72.3 | 79.7 | 90.9 | 98.4 | 96.3 | 86.3 | 72.5 | 61.8 | 59.5 | 514,776 | |
| Twr. Fan CT-1A | 2.0 | 2.1 | 2.2 | 4.3 | 8.1 | 12.5 | 12.5 | 12.5 | 12.5 | 5.7 | 2.1 | 2.0 | 29,539 | |
| Twr. Fan CT-1B | 6.5 | 7.3 | 7.5 | 9.1 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 9.7 | 6.9 | 7.0 | 64,841 | |
| HW pump P-5 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 145,416 | |
| CHW Pump P-7 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 344,268 | |
| CND Pump 10A | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 240,900 | |
| CND Pump 10B | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 160,308 | |
| Fan EF-1 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 10,512 | |
| Fan EF-2 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 23,652 | |
| Fan AH1 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 56,940 | |
| Fan AH2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 89,352 | |
| Fan AH3 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 56,940 | |
| Fan AH5 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 151,548 | |
| Fan AH6 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 121,764 | |
| Fan AH7 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 64,824 | |
| Fan AHS1 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 29,779 | |
| Fan AHS4 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 198,852 | |
| Fan AH-8 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 28,908 | |
| Fan AH-9 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| Fan AH-10 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 15,768 | |
| Fan AH-11A | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 32,412 | |
| Fan AH-11B | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 41,172 | |
| Fan AH-12 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 28,908 | |
| Fan AH-14 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| | | | | | | | | | | | | | | |
| Totals | 525.0 | 533.8 | 537.5 | 547.3 | 560.2 | 575.8 | 583.3 | 581.2 | 571.2 | 549.5 | 532.4 | 530.1 | 4,509,743 | |

| | | | |
|---|---|---|---|
| Total Energy | 15,392 | MMBTU/yr | (electric) |
| Total Energy | | MMBTU/yr | (diesel) |

| ITEM | ECO-A<br>LSTC BUILDING, PROPOSED LIGHTING & HVAC SYSTEMS<br>MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 744,034 | |
| Chiller CH-1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 771,420 | |
| Chiller CH-3 | 48.4 | 57.7 | 62.7 | 68.6 | 75.3 | 86.7 | 94.0 | 92.0 | 81.6 | 68.9 | 57.6 | 55.5 | 480,549 | |
| Twr. Fan CT-1A | 0.6 | 0.8 | 1.0 | 3.2 | 7.4 | 12.5 | 12.5 | 12.5 | 12.5 | 4.8 | 0.7 | 0.6 | 26,565 | |
| Twr. Fan CT-1B | 5.4 | 6.9 | 7.1 | 8.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 9.4 | 6.4 | 6.5 | 61,165 | |
| HW pump P-5 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 145,416 | |
| CHW Pump P-7 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 344,268 | |
| CND Pump 10A | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 240,900 | |
| CND Pump 10B | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 160,308 | |
| Fan EF-1 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 10,512 | |
| Fan EF-2 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 23,652 | |
| Fan AH1 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 56,940 | |
| Fan AH2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 89,352 | |
| Fan AH3 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 56,940 | |
| Fan AH5 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 151,548 | |
| Fan AH6 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 121,764 | |
| Fan AH7 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 64,824 | |
| Fan AHS1 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 29,779 | |
| Fan AHS4 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 198,852 | |
| Fan AH-8 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 28,908 | |
| Fan AH-9 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| Fan AH-10 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 15,768 | |
| Fan AH-11A | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 32,412 | |
| Fan AH-11B | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 41,172 | |
| Fan AH-12 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 28,908 | |
| Fan AH-14 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 459.4 | 470.4 | 475.8 | 485.6 | 498.5 | 515.0 | 522.3 | 520.3 | 509.9 | 488.1 | 469.7 | 467.6 | 4,024,068 | |

Energy Savings 1,658 MMBTU/yr (electric)

Energy Savings MMBTU/yr (diesel)

| ITEM | ECO-A<br>TC-1 & TC-2 BUILDINGS, EXISTING LIGHTING & HVAC SYSTEMS<br>MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 58.3 | 58.3 | 58.3 | 58.3 | 58.3 | 58.3 | 58.3 | 58.3 | 58.3 | 58.3 | 58.3 | 58.3 | 471,139 | |
| Chiller CH-51 | 47.4 | 50.4 | 56.3 | 66.0 | 76.7 | 89.3 | 95.3 | 91.3 | 76.7 | 64.9 | 50.4 | 48.6 | 486,281 | |
| Chiller CH-52 | | | | | | | | | | | | | | |
| Twr. Fan CT-51A | 2.7 | 2.9 | 3.1 | 4.2 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 4.5 | 2.8 | 2.7 | 30,475 | |
| Twr. Fan CT-51B | | | | | | | | | | | | | | |
| CHW Pump P-51 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 239,148 | |
| CHW Pump P-52 | | | | | | | | | | | | | | |
| CND Pump P-60 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 115,632 | |
| CND Pump P-61 | | | | | | | | | | | | | | |
| CND Pump P-65 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 195,348 | |
| CND Pump P-66 | | | | | | | | | | | | | | |
| Boiler B-51 | | | | | | | | | | | | | | 18,771 |
| Boiler B-52 | | | | | | | | | | | | | | |
| HW pump P-70 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 23,652 | |
| HW pump P-71 | | | | | | | | | | | | | | |
| HW pump P-63 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 56,064 | |
| HW pump P-64 | | | | | | | | | | | | | | |
| Fan AH-1 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 76,212 | |
| Fan AH-2 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 18,396 | |
| Fan AH-3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 90,228 | |
| Fan AH-4 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 42,924 | |
| Fan AH-5 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 35,916 | |
| Fan AH-51 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 42,924 | |
| Fan AH-52 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 14,892 | |
| Fan AH-53 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 75,336 | |
| Fan AH-54 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 38,544 | |
| Fan AH-55 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 35,916 | |
| | | | | | | | | | | | | | | |
| Totals | 234.1 | 237.3 | 243.4 | 254.2 | 266.0 | 278.6 | 284.6 | 280.6 | 266.0 | 253.4 | 237.2 | 235.3 | 2,089,027 | 18,771 |

Total Energy 7,130 MMBTU/yr (electric)

Total Energy 1,877 MMBTU/yr (diesel)

| ITEM | ECO-A<br>TC-1 & TC-2 BUILDINGS, PROPOSED LIGHTING & HVAC SYSTEMS<br>MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 380,044 | |
| Chiller CH-51 | 46.6 | 49.2 | 54.7 | 64.5 | 74.9 | 87.3 | 93.5 | 89.1 | 74.8 | 63.3 | 48.9 | 47.4 | 473,214 | |
| Chiller CH-52 | | | | | | | | | | | | | | |
| Twr. Fan CT-51A | 2.6 | 2.8 | 3.0 | 4.2 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 4.4 | 2.7 | 2.6 | 29,700 | |
| Twr. Fan CT-51B | | | | | | | | | | | | | | |
| CHW Pump P-51 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 239,148 | |
| CHW Pump P-52 | | | | | | | | | | | | | | |
| CND Pump P-60 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 115,632 | |
| CND Pump P-61 | | | | | | | | | | | | | | |
| CND Pump P-65 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 195,348 | |
| CND Pump P-66 | | | | | | | | | | | | | | |
| Boiler B-51 | | | | | | | | | | | | | | 19,084 |
| Boiler B-52 | | | | | | | | | | | | | | |
| HW pump P-70 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 23,652 | |
| HW pump P-71 | | | | | | | | | | | | | | |
| HW pump P-63 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 56,064 | |
| HW pump P-64 | | | | | | | | | | | | | | |
| Fan AH-1 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 76,212 | |
| Fan AH-2 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 18,396 | |
| Fan AH-3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 90,228 | |
| Fan AH-4 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 42,924 | |
| Fan AH-5 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 35,916 | |
| Fan AH-51 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 42,924 | |
| Fan AH-52 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 14,892 | |
| Fan AH-53 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 75,336 | |
| Fan AH-54 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 38,544 | |
| Fan AH-55 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 35,916 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 218.3 | 221.1 | 226.8 | 237.8 | 249.3 | 261.7 | 267.9 | 263.5 | 249.2 | 236.8 | 220.7 | 219.1 | 1,984,090 | 19,084 |

Energy Savings 358 MMBTU/yr (electric)

Energy Savings -31 MMBTU/yr (diesel)

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - LSTC AND TEST CELL 1

**PROJECT NO:** 03-0185.05 **DATE:** 4/11/96

**ECO NO.** A

**BY:** HOWARD, D. **CHECKED BY:** CARTER, J.

**PROJECT DESCRIPTION:** Install T-8 Lamps and Electronic Ballasts In 4' Fluorescent Light Fixtures and Compact Fluorescent Lamps in Incandescent Fixtures. Upgrade Exit Lights with LED Kit.

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Installation of new F32T8 electronic ballasts & sockets - 1-lamp | 1 | ea | 1.0 | 30.00 | 30 | 26.80 | 27 | 57 |
| Installation of new F32T8 electronic ballasts & sockets - 2-lamp | 1,109 | ea | 1.0 | 30.00 | 33,270 | 26.80 | 29,721 | 62,991 |
| Installation of new F32T8 electronic ballasts & sockets - 3-lamp | 58 | ea | 1.0 | 30.00 | 1,740 | 34.00 | 1,972 | 3,712 |
| Installation of new F32T8 electronic ballasts & sockets - 4-lamp | 285 | ea | 1.0 | 30.00 | 8,550 | 34.00 | 9,690 | 18,240 |
| Installation of new F32T8 lamps | 3,533 | ea | 0.2 | 30.00 | 21,198 | 2.02 | 7,137 | 28,335 |
| Install 26W compact fluorescent lamps in existing fixtures | 37 | ea | 0.2 | 30.00 | 222 | 21.70 | 803 | 1,025 |
| Install LED retrofit lamp kit in existing exit fixtures | 37 | ea | 1.0 | 30.00 | 1,110 | 12.60 | 466 | 1,576 |
| | | | | SUBTOTAL | 66,120 | | 49,816 | 115,936 |
| | | | | O & P @ 20% | 13,224 | | 9,963 | 23,187 |
| | | | | SUBTOTAL | 79,344 | | 59,779 | 139,123 |
| | | | | DESIGN @ 6% | | | | 8,347 |
| | | | | SUBTOTAL | | | | 147,470 |
| | | | | SIOH @ 5.5% | | | | 8,111 |
| | | | | NMGRT @ 6% | | | | 8,848 |
| | | | | AREA ADJUST. @ 10% | | | | 14,747 |
| | | | | TOTAL | | | | $179,176 |


**HUITT-ZOLLARS, INC.**
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

Life Cycle Cost Analysis — Study: HELSTF.LC

Energy Conservation Investment Program (ECIP) — LCCID FY96

Installation & Location: WSMR

Region data: NEW MEXICO Census Region: 4

Project NO. & Title: 03-0185.05 EEAP ENERGY STUDY - HELSTF FACILITY

Fiscal Year: 1996 Discrete Portion: ECO-A

Analysis Date: 07/24/96 Economic Life: 20 years

Prepared by: JOHN CARTER

ECIP Summary Report

1. Investment

| | | |
|---|---|---|
| A. | Construction Cost | $162,718 |
| B. | SIOH | $8,111 |
| C. | Design Cost | $8,347 |
| D. | Total Cost (1A+1B+1C) | $179,176 |
| E. | Salvage Value of Existing Equip. | $0 |
| F. | Public Utility Company Rebate | $0 |
| G. | Total Investment (1D-1E-1F) | $179,176 |

2. Energy Savings (+) / Costs (-)

Date of NISTIR 85-3273-X used for Discount Factors Oct 1995

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $25. | /Mbtus | 2,016 | Mbtus | $50,319 | 14.47 | $728,121 |
| Elec. Deman | | | | | $0 | 13.47 | $0 |
| Distillate | $. | /Mbtus | 0 | Mbtus | $0 | 17.01 | $0 |
| Residual Oi | $. | /Mbtus | 0 | Mbtus | $0 | 17.23 | $0 |
| Natural Gas | $. | /Mbtus | 0 | Mbtus | $0 | 17.32 | $0 |
| Coal | $. | /Mbtus | 0 | Mbtus | $0 | 14.04 | $0 |
| LPG | $6.5 | /Mbtus | 0 | Mbtus | $0 | 15.64 | $0 |
| Solar | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Geothermal | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Biomass | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Refuse | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Wind | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Other | $7. | /Mbtus | -31 | Mbtus | -$217 | 13.47 | -$2,919 |
| TOTAL | | | 1,985 | Mbtus | $50,103 | | $725,202 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

| | |
|---|---|
| 4. First Year Dollar Savings | $50,103 |
| 5. Simple Payback Period (Years) | 3.58 |
| 6. Total Net Discounted Savings | $725,202 |
| 7. Savings to Investment Ratio | 4.05 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 11.64% |

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | B |
| DATE: | 5/6/96 |
| ECO TITLE: | Provide Motion Sensor Controls For Lights |
| INSTALLATION: | HELSTF |
| LOCATION: | White Sands Missile Range, New Mexico |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 1,454 | MMBTU/yr |
| Diesel Energy Savings | -25 | MMBTU/yr |
| Total Energy Savings | 1,429 | MMBTU/yr |
| Total Cost Savings | 36,117 | $/yr |
| Total Investment | 66,787 | $ |
| Simple Payback | 1.85 | yrs |
| SIR | 7.83 | |

B. ECO Description:

Install 201 ceiling mounted motion sensors in various areas of the LSTC and TC-1 buildings. Recircuit the area light fixtures to allow the new sensors to turn off the lights during unoccupied periods. The sensors shall be the ceiling mounted type and shall generally cover 2,000 sqft of area in a 360° pattern. This ECO will require design of the lighting control system, installation of the sensors and recircuiting of the existing lights.

C. Discussion:

Some of the areas of the LSTC and TC-1 buildings are unoccupied large portions of the work day. These areas typically have 4' fluorescent lighting which is left on during these unoccupied periods. Typical areas considered by this ECO are mechanical / electrical equipment rooms, storage rooms, restrooms, offices, conference rooms, computer centers and other miscellaneous areas.

Motion sensors should be installed on the ceilings of these areas to sense the unoccupied periods, turn off the lights and save the unneeded lighting energy. Since these areas have shelving and other partitions throughout, careful consideration should be given to the type of sensor to be used. It is conservatively estimated that 50% of the work day, these areas are unoccupied. This estimate is based on field observations made during the site visit. Since this retrofit will reduce the building lighting load, there will be a savings in HVAC cooling energy, and a penalty in heating energy.

D. Savings Calculations:

The monthly peak demand and energy consumption of the lighting and HVAC systems were calculated using the Trace 600 computer program.[1] LSTC and TC-1 lighting systems proposed in ECO A were modeled as initial conditions, in order to take into account the previously derived savings. Field data obtained from the buildings was used to create these computer building models.[2]

The monthly peak demand and energy consumption of the ECO B proposed lighting systems were calculated using the Trace 600 computer program. Equipment lists of the proposed lighting system used to create these computer building models are shown on pages B-36 to B-60.

Once the computer simulations were completed, the total annual demand costs and energy consumptions of the initial and proposed lighting systems were compared to determine the annual savings from this ECO. These savings calculations are shown on pages B-61 to B-64.

E. Cost Estimate:

The total implementation costs for this ECO were estimated on page B-65. Manufacturers data on sample sensor equipment used to estimate costs is provided in Appendix E (Volume II, Tab 5).

F. Life Cycle Cost Analysis.

A life cycle cost analysis was performed on this ECO using the program LCCID and data from the above calculations. The summary sheet for the life cycle cost analysis is shown on page B-66. The "Other" fuel type shown in Section # 2 is for diesel fuel consumption. The results of the analysis are listed in the project summary on page B-34.

REFERENCES

1. See Appendix G (Volume II, Tab 7) for computer model input assumptions and data, and energy consumption output data.

2. See Appendix F (Volume II, Tab 6) for building field data and existing lighting system data.

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC
ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | FIXTURE RETROFIT BY ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Stairs - East and West | 18 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breakers | NO | 1,116 W | 24 | 7 | 52 | 9,749 | |
| Communications - B-8 | 34 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breakers | NO | 2,108 W | 24 | 7 | 52 | 18,415 | |
| Mech. Room - B-27 | 31 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breakers | YES | 1,922 W | 1 | 5 | 52 | 500 | |
| Battery Room - B-29 | 4 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Local Switch | NO | 112 W | 24 | 7 | 52 | 978 | |
| Corridor - B-1 | 9 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breakers | NO | 558 W | 24 | 7 | 52 | 4,875 | |
| Janitor Supplies / Break Room - B-18 | 12 | Electronic Ballast and 3-FO32/T8 Lamps | 90 W | Local Switches | YES | 1,080 W | 1 | 5 | 52 | 281 | |
| Elec/HVAC Control Room - B-32 | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | YES | 372 W | 1 | 5 | 52 | 97 | |
| Janitor Closet | 1 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Local Switch | YES | 28 W | 1 | 5 | 52 | 7 | |
| Restroom | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 62 W | 3 | 5 | 52 | 48 | |
| AHU Vestibule | 11 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breakers | NO | 682 W | 24 | 7 | 52 | 5,958 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC
ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | FIXTURE RETROFIT BY ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Magnetic Tape Storage - B-18 | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 372 W | 1 | 5 | 52 | 97 | |
| Aerobics Room | 10 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 620 W | 1 | 5 | 52 | 161 | |
| Men's Restroom | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 186 W | 3 | 5 | 52 | 145 | |
| Women's Restroom | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 186 W | 3 | 5 | 52 | 145 | |
| Vestibule | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | NO | 62 W | 24 | 7 | 52 | 542 | |
| Office | 2 | Electronic Ballast and 3-FO32/T8 Lamps | 90 W | Local Switch | YES | 180 W | 5 | 5 | 52 | 234 | |
| Library | 23 | Electronic Ballast and 3-FO32/T8 Lamps | 90 W | Local Switch | YES | 2,070 W | 1 | 5 | 52 | 538 | |
| Office - B-17B | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 124 W | 5 | 5 | 52 | 161 | |
| Corridor - B-3 | 12 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breakers | NO | 744 W | 24 | 7 | 52 | 6,500 | |
| Corridor - B-2 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breakers | NO | 248 W | 24 | 7 | 52 | 2,167 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | FIXTURE RETROFIT BY ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| I&C Electrical Shop - B-17D | 24 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | NO | 1,488 W | 24 | 7 | 52 | 12,999 | |
| Office - B-17C | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 228 W | 5 | 5 | 52 | 296 | |
| Storage - B-19 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 1 | 5 | 52 | 64 | |
| Storage - B-20 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 1 | 5 | 52 | 64 | |
| Storage - B-21 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 1 | 5 | 52 | 64 | |
| Vestibule | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | NO | 124 W | 24 | 7 | 52 | 1,083 | |
| Vestibule - B-5 | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | NO | 124 W | 24 | 7 | 52 | 1,083 | |
| Air Duct - B-30 | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 186 W | 1 | 5 | 52 | 48 | |
| Break Room - B-12 | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 372 W | 2 | 5 | 52 | 193 | |
| Kitchen - B-12A | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 186 W | 1 | 5 | 52 | 48 | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conference - B-13 | 1 | Electronic Ballast and 4-FO32/T8 Lamps | 114 | W | Local Switch | YES | 114 | W | 2 | 5 | 52 | 59 | |
| Electrical Equipment - B-24 | 14 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Breakers | NO | 868 | W | 24 | 7 | 52 | 7,583 | |
| Fallout Shelter Supply - B-22 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Local Switch | YES | 248 | W | 1 | 5 | 52 | 64 | |
| Hughes - B-9 | 6 | Electronic Ballast and 4-FO32/T8 Lamps | 114 | W | Local Switch | YES | 684 | W | 5 | 5 | 52 | 889 | |
| Hughes O&M Test Cell B Group - B-10 | 12 | Electronic Ballast and 4-FO32/T8 Lamps | 114 | W | Local Switches | YES | 1,368 | W | 5 | 5 | 52 | 1,778 | |
| Hughes O&M Camera Lab - B-11 | 18 | Electronic Ballast and 4-FO32/T8 Lamps | 114 | W | Local Switches | YES | 2,052 | W | 5 | 5 | 52 | 2,668 | |
| Corridor - B-4 | 15 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Breakers | NO | 930 | W | 24 | 7 | 52 | 8,124 | |
| Hughes SLBD Optics Lab | 32 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Local Switches | YES | 1,984 | W | 5 | 5 | 52 | 2,579 | |
| Equipment Room - B-28 | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Local Switch | YES | 186 | W | 5 | 5 | 52 | 242 | |
| US Navy Library - B-11A | 6 | Electronic Ballast and 4-FO32/T8 Lamps | 114 | W | Local Switch | YES | 684 | W | 1 | 5 | 52 | 178 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | FIXTURE RETROFIT BY ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Office - 105C | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 5 | 5 | 52 | 322 | |
| Office - 105F | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 372 W | 5 | 5 | 52 | 484 | |
| Office - 105E | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 5 | 5 | 52 | 322 | |
| Office - 105D | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 5 | 5 | 52 | 322 | |
| Office - 107A | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 5 | 5 | 52 | 322 | |
| Office - 107C | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 5 | 5 | 52 | 322 | |
| Office - 107 | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 124 W | 5 | 5 | 52 | 161 | |
| Vault - 107B | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 124 W | 1 | 5 | 52 | 32 | |
| Janitor | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 62 W | 1 | 5 | 52 | 16 | |
| Corridor - 112 | 16 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | NO | 992 W | 24 | 7 | 52 | 8,666 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | FIXTURE RETROFIT BY ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Corridor - 104 | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | NO | 124 W | 24 | 7 | 52 | 1,083 | |
| Women's Restroom | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 124 W | 3 | 5 | 52 | 97 | |
| Men's Restroom | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 124 W | 3 | 5 | 52 | 97 | |
| Women's Restroom | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 186 W | 3 | 5 | 52 | 145 | |
| Cable/Power Terminals | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 124 W | 1 | 5 | 52 | 32 | |
| I & C shop - 119 | 28 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | YES | 1,736 W | 5 | 5 | 52 | 2,257 | |
| Test Cell 4 Control Room - 119A | 28 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switches | YES | 3,192 W | 5 | 5 | 52 | 4,150 | |
| Cable Transition Room - 119B | 8 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 496 W | 1 | 5 | 52 | 129 | |
| Observation - 121 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 1 | 5 | 52 | 64 | |
| Site control Room - 123 | 21 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | YES | 1,302 W | 5 | 5 | 52 | 1,693 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC
ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | FIXTURE RETROFIT BY ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Site Control Office - 123A | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 124 W | 5 | 5 | 52 | 161 | |
| Vestibule | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | NO | 62 W | 24 | 7 | 52 | 542 | |
| Observation - 125 | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 186 W | 1 | 5 | 52 | 48 | |
| Corridor - 124 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | NO | 248 W | 24 | 7 | 52 | 2,167 | |
| | 4 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | NO | 456 W | 24 | 7 | 52 | 3,984 | |
| Auxiliary Control Room - 128 | 20 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switches | NO | 2,280 W | 24 | 7 | 52 | 19,918 | |
| Operational Controllers Computer Room - 127A | 24 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | NO | 1,488 W | 24 | 7 | 52 | 12,999 | |
| MTIR & Vacuum Chamber control Room - 127 | 31 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | NO | 1,922 W | 24 | 7 | 52 | 16,791 | |
| Cable/Power Terminals | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 124 W | 1 | 5 | 52 | 32 | |
| Office - 135 | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 124 W | 5 | 5 | 52 | 161 | |

| AREA SERVED | QTY. | FIXTURE RETROFIT BY ECO No. A | FIXTURE LOAD | | CONTROL | SENSOR INSTALLED | AREA LOAD | | HRS | DAYS | WKS | KWH | MCF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conference Room - 135A | 5 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Local Switch | YES | 310 | W | 2 | 5 | 52 | 161 | |
| Office - 137A | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 | W | Local Switch | YES | 228 | W | 5 | 5 | 52 | 296 | |
| Office - 137B | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 | W | Local Switch | YES | 228 | W | 5 | 5 | 52 | 296 | |
| Office - 137C | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 | W | Local Switch | YES | 228 | W | 5 | 5 | 52 | 296 | |
| Office - 137D | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 | W | Local Switch | YES | 228 | W | 5 | 5 | 52 | 296 | |
| Office - 137E | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 | W | Local Switch | YES | 228 | W | 5 | 5 | 52 | 296 | |
| Office - 137F | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 | W | Local Switch | YES | 228 | W | 5 | 5 | 52 | 296 | |
| Office - 137G | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 | W | Local Switch | YES | 228 | W | 5 | 5 | 52 | 296 | |
| Corridor & Coffee Room - 137H | 7 | Electronic Ballast and 2-FO32/T8 Lamps | 62 | W | Local Switch | YES | 434 | W | 2 | 5 | 52 | 226 | |
| Projection Room - 139 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 | W | Local Switch | YES | 228 | W | 1 | 5 | 52 | 59 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | FIXTURE RETROFIT BY ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Conference Room "A" - 141 | 12 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 744 W | 2 | 5 | 52 | 387 | |
| Office - 147C | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 124 W | 5 | 5 | 52 | 161 | |
| Office - 147 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 5 | 5 | 52 | 322 | |
| Office - 147A | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 5 | 5 | 52 | 322 | |
| Office - 147B | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 5 | 5 | 52 | 322 | |
| Corridor - 150 | 8 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | NO | 496 W | 24 | 7 | 52 | 4,333 | |
| Office - 149 | 8 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 496 W | 5 | 5 | 52 | 645 | |
| Office - 149A | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 5 | 5 | 52 | 322 | |
| Office - 149B | 4 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 456 W | 5 | 5 | 52 | 593 | |
| Office - 151 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 5 | 5 | 52 | 322 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC
ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | FIXTURE RETROFIT BY ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Office - 153 | 8 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 496 W | 5 | 5 | 52 | 645 | |
| Office - 153A | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 228 W | 5 | 5 | 52 | 296 | |
| Office - 153B | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 228 W | 5 | 5 | 52 | 296 | |
| Conference Room "B" - 155 | 8 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 912 W | 2 | 5 | 52 | 474 | |
| Electrical Chase - 106A | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 124 W | 1 | 5 | 52 | 32 | |
| Communication Room - 106B | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 62 W | 1 | 5 | 52 | 16 | |
| Office - 106 | 8 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 496 W | 5 | 5 | 52 | 645 | |
| Vestibule - 108 | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | NO | 62 W | 24 | 7 | 52 | 542 | |
| Observation Room - 159 | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 186 W | 1 | 5 | 52 | 48 | |
| User's Control Room - 110 | 23 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | NO | 1,426 W | 24 | 7 | 52 | 12,458 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC
ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | FIXTURE RETROFIT BY ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| CCTV Equipment Room - 116 | 18 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | NO | 1,116 W | 24 | 7 | 52 | 9,749 | |
| Timing Station Room - 116A | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 5 | 5 | 52 | 322 | |
| Office - 120 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 5 | 5 | 52 | 322 | |
| MET Room - 120A | 12 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switches | NO | 1,368 W | 24 | 7 | 52 | 11,951 | |
| Data Processing Computer Room - 122 | 21 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switches | NO | 2,394 W | 24 | 7 | 52 | 20,914 | |
| HELDPS Break Room | 8 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 496 W | 2 | 5 | 52 | 258 | |
| Tape Library | 8 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 496 W | 1 | 5 | 52 | 129 | |
| Telemetry Room - 148A | 15 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switches | NO | 1,710 W | 24 | 7 | 52 | 14,939 | |
| Office 148 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 5 | 5 | 52 | 322 | |
| Office 148B | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 124 W | 5 | 5 | 52 | 161 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | FIXTURE RETROFIT BY ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Image Analysis Room - 146A | 10 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | NO | 620 W | 24 | 7 | 52 | 5,416 | |
| Storage - 146B | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 62 W | 1 | 5 | 52 | 16 | |
| Office - 146 | 5 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 310 W | 5 | 5 | 52 | 403 | |
| Corridor - 157 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | NO | 248 W | 24 | 7 | 52 | 2,167 | |
| | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | NO | 186 W | 24 | 7 | 52 | 1,625 | |
| Office - 157 | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 62 W | 5 | 5 | 52 | 81 | |
| Office - 156 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 228 W | 5 | 5 | 52 | 296 | |
| Storage - 156A | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 62 W | 1 | 5 | 52 | 16 | |
| Main Stairs - 201 | 5 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | NO | 310 W | 24 | 7 | 52 | 2,708 | |
| East Stairs - 209 | 5 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | NO | 310 W | 24 | 7 | 52 | 2,708 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC
ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | FIXTURE RETROFIT BY ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Corridor - 203 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | NO | 248 W | 24 | 7 | 52 | 2,167 | |
| Storage - 225 | 1 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Local Switch | YES | 28 W | 1 | 5 | 52 | 7 | |
| Computer Room - 205 | 3 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 342 W | 5 | 5 | 52 | 445 | |
| Test Cell #3 Control - 206 | 22 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | NO | 1,364 W | 24 | 7 | 52 | 11,916 | |
| Office - 206A | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 186 W | 5 | 5 | 52 | 242 | |
| Office - 206B | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 5 | 5 | 52 | 322 | |
| Test Cell #3A Instrumentaion - 204 | 22 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | NO | 1,364 W | 24 | 7 | 52 | 11,916 | |
| Office - 206C | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 124 W | 5 | 5 | 52 | 161 | |
| Test Cell #3B Instrumentaion - 207 | 26 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | NO | 1,612 W | 24 | 7 | 52 | 14,082 | |
| Storage - 208 | 1 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Local Switch | YES | 28 W | 1 | 5 | 52 | 7 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | FIXTURE RETROFIT BY ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Corridor - 232 | 10 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | NO | 620 W | 24 | 7 | 52 | 5,416 | |
| Office - 210 | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 372 W | 5 | 5 | 52 | 484 | |
| Office - 210A | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 372 W | 5 | 5 | 52 | 484 | |
| Office - 211 | 7 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 798 W | 5 | 5 | 52 | 1,037 | |
| Office - 211A | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 372 W | 5 | 5 | 52 | 484 | |
| Reception - 212 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 228 W | 5 | 5 | 52 | 296 | |
| Office - 212A | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 5 | 5 | 52 | 322 | |
| Office - 212B | 5 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 310 W | 5 | 5 | 52 | 403 | |
| Office - 212C | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 228 W | 5 | 5 | 52 | 296 | |
| Office - 213 | 5 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 310 W | 5 | 5 | 52 | 403 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC
ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | FIXTURE RETROFIT BY ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Office - 215 | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 186 W | 5 | 5 | 52 | 242 | |
| Janitor - 214 | 1 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Local Switch | YES | 28 W | 1 | 5 | 52 | 7 | |
| Office - 217 | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 248 W | 5 | 5 | 52 | 322 | |
| Mens Restroom - 216 | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 124 W | 3 | 5 | 52 | 97 | |
| Womens Restroom - 218 | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 62 W | 3 | 5 | 52 | 48 | |
| Office - 219 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 228 W | 5 | 5 | 52 | 296 | |
| Office - 221 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 228 W | 5 | 5 | 52 | 296 | |
| Office - 222 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 228 W | 5 | 5 | 52 | 296 | |
| Office - 220 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 228 W | 5 | 5 | 52 | 296 | |
| Corridor - 300 | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | NO | 372 W | 24 | 7 | 52 | 3,250 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC
ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | FIXTURE RETROFIT BY ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Copy Room - 308 | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 62 W | 2 | 5 | 52 | 32 | |
| Office - 312 | 4 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 456 W | 4 | 5 | 52 | 474 | |
| Office - 309 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 228 W | 4 | 5 | 52 | 237 | |
| Office - 307 | 5 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 310 W | 4 | 5 | 52 | 322 | |
| Office - 305 | 4 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 456 W | 4 | 5 | 52 | 474 | |
| Office - 304 | 3 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 342 W | 4 | 5 | 52 | 356 | |
| VAX - 301 | 30 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switches | NO | 3,420 W | 4 | 5 | 52 | 3,557 | |
| Office - 306 | 4 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 456 W | 4 | 5 | 52 | 474 | |
| Office - 303 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 228 W | 4 | 5 | 52 | 237 | |
| Office - 302 | 4 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 456 W | 4 | 5 | 52 | 474 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC
ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | FIXTURE RETROFIT BY ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Office - 310 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 228 W | 4 | 5 | 52 | 237 | |
| Office - 311 | 9 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switches | YES | 1,026 W | 4 | 5 | 52 | 1,067 | |
| Office - 313 | 2 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 228 W | 4 | 5 | 52 | 237 | |
| Office - 314 | 3 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 342 W | 4 | 5 | 52 | 356 | |
| Office - 315 | 1 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 114 W | 4 | 5 | 52 | 119 | |
| Stairs - 223 | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | NO | 186 W | 24 | 7 | 52 | 1,625 | |
| Corridor - 230 | 12 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | NO | 744 W | 24 | 7 | 52 | 6,500 | |
| Office - 230A | 5 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | YES | 310 W | 1 | 5 | 52 | 81 | |
| Office - 230B | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | YES | 248 W | 1 | 5 | 52 | 64 | |
| Office - 230C | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | YES | 186 W | 1 | 5 | 52 | 48 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC
ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | FIXTURE RETROFIT BY ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Office - 230D | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | YES | 186 W | 1 | 5 | 52 | 48 | |
| Office - 230E | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | YES | 248 W | 1 | 5 | 52 | 64 | |
| Office - 230F | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | YES | 186 W | 1 | 5 | 52 | 48 | |
| Office - 230G | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | YES | 186 W | 1 | 5 | 52 | 48 | |
| Office - 230H | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | YES | 186 W | 1 | 5 | 52 | 48 | |
| Office - 230I | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | YES | 186 W | 1 | 5 | 52 | 48 | |
| Office - 230J | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | | YES | 186 W | 1 | 5 | 52 | 48 | |
| Storage - 330 | 19 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | NO | 1,178 W | 24 | 7 | 52 | 10,291 | |
| Stair - 224 | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | NO | 186 W | 24 | 7 | 52 | 1,625 | |
| Corridor - 231 | 3 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Breaker | NO | 186 W | 24 | 7 | 52 | 1,625 | |

PROPOSED RETROFIT LIST FOR: HELSTF - LSTC

ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | FIXTURE RETROFIT BY ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Office - 231A | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 372 W | 1 | 5 | 52 | 97 | |
| Office - 231B | 23 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | NO | 1,426 W | 24 | 7 | 52 | 12,458 | |
| Microvax - 231C | 16 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | NO | 992 W | 24 | 7 | 52 | 8,666 | |
| Exits | 15 | LED Retrofit Kit 1-1.8 Watt Unit | 1.8 W | Breaker | NO | 27 W | 24 | 7 | 52 | 236 | |
| TOTAL ENERGY USE | | | | | | 94,033 W | | | | 387,225 | 0 |

LIGHTING EQUIPMENT LIST FOR: HELSTF - TEST CELL 1

ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | RETROFIT DESCRIPTION ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| North Optics Room - 101 | 45 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | NO | 2,790 W | 24 | 7 | 52 | 24,373 | |
| South Optics Room - 102 | 30 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | NO | 1,860 W | 24 | 7 | 52 | 16,249 | |
| | 2 | NO CHANGE | 200 W | Local Switch | NO | 400 W | 24 | 7 | 52 | 3,494 | |
| ETA Control Room - 103 | 9 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 558 W | 3 | 5 | 52 | 435 | |
| Storage - 104 | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 62 W | 1 | 5 | 52 | 16 | |
| Vestibule - 105 | 1 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | NO | 62 W | 24 | 7 | 52 | 542 | |
| Vestibule - 101 | 1 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Local Switch | YES | 28 W | 1 | 5 | 52 | 7 | |
| Optics Room - 102 | 12 | NO CHANGE | 460 W | Breakers | NO | 5,520 W | 24 | 7 | 52 | 48,223 | |
| | 6 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Breakers | NO | 168 W | 24 | 7 | 52 | 1,468 | |
| Vestibule - 103 | 1 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Breaker | YES | 28 W | 1 | 5 | 52 | 7 | |

LIGHTING EQUIPMENT LIST FOR: HELSTF - TEST CELL 1
ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | RETROFIT DESCRIPTION ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Device Room - 104 | 30 | NO CHANGE | 460 W | Breakers | NO | 13,800 W | 24 | 7 | 52 | 120,557 | |
| | 6 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Breaker | NO | 168 W | 24 | 7 | 52 | 1,468 | |
| Local Loop Electronics Room - 104A | 10 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switches | YES | 1,140 W | 2 | 5 | 52 | 593 | |
| BTA Room - 105 | 16 | NO CHANGE | 460 W | Breakers | NO | 7,360 W | 24 | 7 | 52 | 64,297 | |
| | 2 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Breaker | NO | 56 W | 24 | 7 | 52 | 489 | |
| Vestibule - 106 | 1 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Breaker | YES | 28 W | 1 | 5 | 52 | 7 | |
| PT Service Room - 107 | 4 | NO CHANGE | 300 W | Local Switch | NO | 1,200 W | 24 | 7 | 52 | 10,483 | |
| | 1 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | | NO | 28 W | 24 | 7 | 52 | 245 | |
| Mechanical Equipment-108 | 2 | NO CHANGE | 300 W | Local Switch | YES | 600 W | 1 | 5 | 52 | 156 | |
| | 1 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | | YES | 28 W | 1 | 5 | 52 | 7 | |

LIGHTING EQUIPMENT LIST FOR: HELSTF - TEST CELL 1
ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | RETROFIT DESCRIPTION ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Optics Electronics Room - 109 | 21 | Electronic Ballast and 3-FO32/T8 Lamps | 90 W | Local Switch | NO | 1,890 W | 24 | 7 | 52 | 16,511 | |
| | 4 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | NO | 248 W | 24 | 7 | 52 | 2,167 | |
| Elevator Vestibule - 110 | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 124 W | 2 | 5 | 52 | 64 | |
| Stairs | 6 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switches | NO | 372 W | 24 | 7 | 52 | 3,250 | |
| Electronics Equipment Room - 201 | 6 | NO CHANGE | 300 W | Local Switches | NO | 1,800 W | 24 | 7 | 52 | 15,725 | |
| | 2 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Local Switch | NO | 56 W | 24 | 7 | 52 | 489 | |
| Mechanical Room - 203 | 4 | NO CHANGE | 300 W | Local Switch | YES | 1,200 W | 1 | 5 | 52 | 312 | |
| | 2 | NO CHANGE | 460 W | Local Switch | YES | 920 W | 1 | 5 | 52 | 239 | |
| | 4 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Local Switch | YES | 112 W | 1 | 5 | 52 | 29 | |
| P.T. Tower - | 10 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | NO | 620 W | 24 | 7 | 52 | 5,416 | |

LIGHTING EQUIPMENT LIST FOR: HELSTF - TEST CELL 1

ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | RETROFIT DESCRIPTION ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| 204 | 4 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Local Switch | NO | 112 W | 24 | 7 | 52 | 978 | |
| Elevator Vestibule - 205 | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 124 W | 2 | 5 | 52 | 64 | |
| P.T. Tower - 301 | 12 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | NO | 744 W | 24 | 7 | 52 | 6,500 | |
| Elevator Vestibule - 302 | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 124 W | 2 | 5 | 52 | 64 | |
| P.T. Tower - 401 | 11 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | NO | 682 W | 24 | 7 | 52 | 5,958 | |
| Elevator Vestibule - 402 | 2 | Electronic Ballast and 2-FO32/T8 Lamps | 62 W | Local Switch | YES | 124 W | 2 | 5 | 52 | 64 | |
| HPOC Enclosure | 4 | Electronic Ballast and 4-FO32/T8 Lamps | 114 W | Local Switch | YES | 456 W | 2 | 5 | 52 | 237 | |
| P.T. Tower - 501 | 4 | NO CHANGE | 460 W | Local Switch | NO | 1,840 W | 24 | 7 | 52 | 16,074 | |
| Building Exterior | 6 | Electronic Ballast and 1-F26/DTT Lamp | 28 W | Photocell | NO | 168 W | 12 | 7 | 52 | 734 | |
| Building Exterior | 11 | NO CHANGE | 200 W | Photocell | NO | 2,200 W | 12 | 7 | 52 | 9,610 | |

LIGHTING EQUIPMENT LIST FOR: HELSTF - TEST CELL 1
ECO No. B: Install Occupancy Sensors

| AREA SERVED | QTY. | RETROFIT DESCRIPTION ECO No. A | FIXTURE LOAD | CONTROL | SENSOR INSTALLED | AREA LOAD | OPER. TIMES | | | ANNUAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HRS | DAYS | WKS | KWH | MCF |
| Building Exterior | 6 | NO CHANGE | 95 W | Photocell | NO | 570 W | 12 | 7 | 52 | 2,490 | |
| Exits | 22 | LED Retrofit Kit 1-1.8 Watt Unit | 1.8 W | Breaker | NO | 40 W | 24 | 7 | 52 | 349 | |
| TOTAL ENERGY USE | | | | | | 50,410 W | | | | 380,440 | 0 |

| ITEM | ECO-B<br>LSTC BUILDING, ECO-A LIGHTING & HVAC SYSTEMS<br>MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 744,034 | |
| Chiller CH-1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 771,420 | |
| Chiller CH-3 | 48.4 | 57.7 | 62.7 | 68.6 | 75.3 | 86.7 | 94.0 | 92.0 | 81.6 | 68.9 | 57.6 | 55.5 | 480,549 | |
| Twr. Fan CT-1A | 0.6 | 0.8 | 1.0 | 3.2 | 7.4 | 12.5 | 12.5 | 12.5 | 12.5 | 4.8 | 0.7 | 0.6 | 26,565 | |
| Twr. Fan CT-1B | 5.4 | 6.9 | 7.1 | 8.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 9.4 | 6.4 | 6.5 | 61,165 | |
| HW pump P-5 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 145,416 | |
| CHW Pump P-7 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 344,268 | |
| CND Pump 10A | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 240,900 | |
| CND Pump 10B | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 160,308 | |
| Fan EF-1 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 10,512 | |
| Fan EF-2 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 23,652 | |
| Fan AH1 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 56,940 | |
| Fan AH2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 89,352 | |
| Fan AH3 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 56,940 | |
| Fan AH5 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 151,548 | |
| Fan AH6 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 121,764 | |
| Fan AH7 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 64,824 | |
| Fan AHS1 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 29,779 | |
| Fan AHS4 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 198,852 | |
| Fan AH-8 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 28,908 | |
| Fan AH-9 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| Fan AH-10 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 15,768 | |
| Fan AH-11A | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 32,412 | |
| Fan AH-11B | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 41,172 | |
| Fan AH-12 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 28,908 | |
| Fan AH-14 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| | | | | | | | | | | | | | | |
| Totals | 459.4 | 470.4 | 475.8 | 485.6 | 498.5 | 515.0 | 522.3 | 520.3 | 509.9 | 488.1 | 469.7 | 467.6 | 4,024,068 | |

Total Energy 13,734 MMBTU/yr (electric)

Total Energy MMBTU/yr (diesel)

| ITEM | ECO-B<br>LSTC BUILDING, PROPOSED LIGHTING & HVAC SYSTEMS<br>MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 376,570 | |
| Chiller CH-1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 771,420 | |
| Chiller CH-3 | 47.6 | 54.3 | 62.7 | 68.6 | 75.3 | 86.7 | 94.0 | 92.0 | 81.6 | 68.9 | 57.6 | 52.0 | 453,528 | |
| Twr. Fan CT-1A | 0.6 | 0.8 | 1.0 | 3.2 | 7.4 | 12.5 | 12.5 | 12.5 | 12.5 | 4.8 | 0.7 | 0.6 | 25,060 | |
| Twr. Fan CT-1B | 5.3 | 6.2 | 7.1 | 8.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 9.4 | 6.4 | 6.0 | 58,066 | |
| HW pump P-5 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 145,416 | |
| CHW Pump P-7 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 344,268 | |
| CND Pump 10A | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 240,900 | |
| CND Pump 10B | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 160,308 | |
| Fan EF-1 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 10,512 | |
| Fan EF-2 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 23,652 | |
| Fan AH1 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 56,940 | |
| Fan AH2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 89,352 | |
| Fan AH3 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 56,940 | |
| Fan AH5 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 151,548 | |
| Fan AH6 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 121,764 | |
| Fan AH7 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 64,824 | |
| Fan AHS1 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 29,779 | |
| Fan AHS4 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 198,852 | |
| Fan AH-8 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 28,908 | |
| Fan AH-9 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| Fan AH-10 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 15,768 | |
| Fan AH-11A | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 32,412 | |
| Fan AH-11B | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 41,172 | |
| Fan AH-12 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 28,908 | |
| Fan AH-14 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 458.5 | 466.3 | 475.8 | 485.6 | 498.5 | 515.0 | 522.3 | 520.3 | 509.9 | 488.1 | 469.7 | 463.6 | 3,624,979 | |

Energy Savings 1,362 MMBTU/yr (electric)

Energy Savings MMBTU/yr (diesel)

| ITEM | ECO-B<br>TC-1 & TC-2 BUILDINGS, ECO-A LIGHTING & HVAC SYSTEMS<br>MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 380,044 | |
| Chiller CH-51 | 46.6 | 49.2 | 54.7 | 64.5 | 74.9 | 87.3 | 93.5 | 89.1 | 74.8 | 63.3 | 48.9 | 47.4 | 473,214 | |
| Chiller CH-52 | | | | | | | | | | | | | | |
| Twr. Fan CT-51A | 2.6 | 2.8 | 3.0 | 4.2 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 4.4 | 2.7 | 2.6 | 29,700 | |
| Twr. Fan CT-51B | | | | | | | | | | | | | | |
| CHW Pump P-51 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 239,148 | |
| CHW Pump P-52 | | | | | | | | | | | | | | |
| CND Pump P-60 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 115,632 | |
| CND Pump P-61 | | | | | | | | | | | | | | |
| CND Pump P-65 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 195,348 | |
| CND Pump P-66 | | | | | | | | | | | | | | |
| Boiler B-51 | | | | | | | | | | | | | | 19,084 |
| Boiler B-52 | | | | | | | | | | | | | | |
| HW pump P-70 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 23,652 | |
| HW pump P-71 | | | | | | | | | | | | | | |
| HW pump P-63 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 56,064 | |
| HW pump P-64 | | | | | | | | | | | | | | |
| Fan AH-1 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 76,212 | |
| Fan AH-2 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 18,396 | |
| Fan AH-3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 90,228 | |
| Fan AH-4 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 42,924 | |
| Fan AH-5 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 35,916 | |
| Fan AH-51 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 42,924 | |
| Fan AH-52 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 14,892 | |
| Fan AH-53 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 75,336 | |
| Fan AH-54 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 38,544 | |
| Fan AH-55 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 35,916 | |
| | | | | | | | | | | | | | | |
| Totals | 218.3 | 221.1 | 226.8 | 237.8 | 249.3 | 261.7 | 267.9 | 263.5 | 249.2 | 236.8 | 220.7 | 219.1 | 1,984,090 | 19,084 |

Total Energy 6,772 MMBTU/yr (electric)

Total Energy 1,908 MMBTU/yr (diesel)

| ITEM | ECO-B TC-1 & TC-2 BUILDINGS, PROPOSED LIGHTING & HVAC SYSTEMS MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 356,670 | |
| Chiller CH-51 | 46.6 | 49.2 | 54.7 | 64.5 | 74.9 | 87.3 | 93.5 | 89.1 | 74.8 | 63.3 | 48.9 | 47.4 | 469,708 | |
| Chiller CH-52 | | | | | | | | | | | | | | |
| Twr. Fan CT-51A | 2.6 | 2.8 | 3.0 | 4.2 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 4.4 | 2.7 | 2.6 | 29,520 | |
| Twr. Fan CT-51B | | | | | | | | | | | | | | |
| CHW Pump P-51 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 239,148 | |
| CHW Pump P-52 | | | | | | | | | | | | | | |
| CND Pump P-60 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 115,632 | |
| CND Pump P-61 | | | | | | | | | | | | | | |
| CND Pump P-65 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 195,348 | |
| CND Pump P-66 | | | | | | | | | | | | | | |
| Boiler B-51 | | | | | | | | | | | | | | 19,331 |
| Boiler B-52 | | | | | | | | | | | | | | |
| HW pump P-70 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 23,652 | |
| HW pump P-71 | | | | | | | | | | | | | | |
| HW pump P-63 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 56,064 | |
| HW pump P-64 | | | | | | | | | | | | | | |
| Fan AH-1 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 76,212 | |
| Fan AH-2 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 18,396 | |
| Fan AH-3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 90,228 | |
| Fan AH-4 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 42,924 | |
| Fan AH-5 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 35,916 | |
| Fan AH-51 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 42,924 | |
| Fan AH-52 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 14,892 | |
| Fan AH-53 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 75,336 | |
| Fan AH-54 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 38,544 | |
| Fan AH-55 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 35,916 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 218.3 | 221.1 | 226.8 | 237.8 | 249.3 | 261.7 | 267.9 | 263.5 | 249.2 | 236.8 | 220.7 | 219.1 | 1,957,030 | 19,331 |

Energy Savings 92 MMBTU/yr (electric)

Energy Savings -25 MMBTU/yr (diesel)

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: HELSTF - LSTC AND TEST CELL 1

PROJECT NO: 03-0185.05 DATE: 4/11/96

ECO NO. B

BY : HOWARD, D. CHECKED BY: CARTER, J.

PROJECT DESCRIPTION: Install Occupancy Sensors To Turn Off Lights

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Install occupancy sensors in various rooms | 201 | ea | 2.0 | 30.00 | 12,060 | 100.00 | 20,100 | 32,160 |
| Miscellaneous wire, conduit and electrical parts | 201 | ea | 1.0 | 30.00 | 6,030 | 25.00 | 5,025 | 11,055 |
| SUBTOTAL | | | | | 18,090 | | 25,125 | 43,215 |
| O & P @ 20% | | | | | 3,618 | | 5,025 | 8,643 |
| SUBTOTAL | | | | | 21,708 | | 30,150 | 51,858 |
| DESIGN @ 6% | | | | | | | | 3,111 |
| SUBTOTAL | | | | | | | | 54,969 |
| SIOH @ 5.5% | | | | | | | | 3,023 |
| NMGRT @ 6% | | | | | | | | 3,298 |
| AREA ADJUST. @ 10% | | | | | | | | 5,497 |
| TOTAL | | | | | | | | $66,787 |

**HUITT-ZOLLARS, INC.**
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

Life Cycle Cost Analysis — Study: HELSTF.LC
Energy Conservation Investment Program (ECIP) — LCCID FY96
Installation & Location: WSMR
Region data: NEW MEXICO    Census Region: 4
Project NO. & Title: 03-0185.05 EEAP ENERGY STUDY - HELSTF FACILITY
Fiscal Year: 1996 Discrete Portion: ECO-B
Analysis Date: 07/24/96 Economic Life: 20 years
Prepared by: JOHN CARTER

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $60,653 |
| B. SIOH | $3,023 |
| C. Design Cost | $3,111 |
| D. Total Cost (1A+1B+1C) | $66,787 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $66,787 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1995

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $25. | /Mbtus | 1,454 | Mbtus | $36,292 | 14.47 | $525,143 |
| Elec. Deman | | | | | $0 | 13.47 | $0 |
| Distillate | $. | /Mbtus | 0 | Mbtus | $0 | 17.01 | $0 |
| Residual Oi | $. | /Mbtus | 0 | Mbtus | $0 | 17.23 | $0 |
| Natural Gas | $. | /Mbtus | 0 | Mbtus | $0 | 17.32 | $0 |
| Coal | $. | /Mbtus | 0 | Mbtus | $0 | 14.04 | $0 |
| LPG | $6.5 | /Mbtus | 0 | Mbtus | $0 | 15.64 | $0 |
| Solar | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Geothermal | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Biomass | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Refuse | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Wind | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Other | $7. | /Mbtus | -25 | Mbtus | -$175 | 13.47 | -$2,354 |
| TOTAL | | | 1,429 | Mbtus | $36,117 | | $522,789 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

| | |
|---|---|
| 4. First Year Dollar Savings | $36,117 |
| 5. Simple Payback Period (Years) | 1.85 |
| 6. Total Net Discounted Savings | $522,789 |
| 7. Savings to Investment Ratio | 7.83 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 15.38% |

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | C |
| DATE: | 5/6/96 |
| ECO TITLE: | Provide Energy Management System |
| INSTALLATION: | HELSTF, LSTC Building, Bldg. TC-1 and TC-2 |
| LOCATION: | White Sands Missile Range, New Mexico |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 4,419 | MMBTU/yr |
| Diesel Energy Savings | 542 | MMBTU/yr |
| Total Energy Savings | 4,961 | MMBTU/yr |
| Total Cost Savings | 114,087 | $/yr |
| Total Investment | 443,021 | $ |
| Simple Payback | 3.88 | yrs |
| SIR | 3.72 | |

B. ECO Description:

Install Energy Management System (EMS) at LSTC, TC-1 and TC-2 buildings. The EMS should be the fully distributed type with stand alone digital controllers in the various equipment areas of the buildings. These controllers should be able to communicate with each other as well as with a central, personal computer-based (PC) control center. This central PC-based control center will be installed at the LSTC building to monitor and control the HVAC systems in all buildings. The TC-1 and TC-2 buildings will be connected to the control center via phone lines. The EMS controllers will be programmed to accomplish the following tasks.

1. In the LSTC building, it will reduce the volume of outside air (OA) from AHU-S1 from the current 7,845 CFM to 2,880 CFM by means of a variable frequency drive. These savings will occur only when the OA conditions are not suitable for the economizer cycle. In the economizer cycle, the unit will deliver up to 7,845 CFM of OA to take full advantage of the free cooling available. Furnish all necessary controls to facilitate the modulation of RA and OA dampers using enthalpy economizer control for AH-1, 2, 3, 5, 6, 7, and 13.

2. In the LSTC building, an optimum start and stop program will be provided to control AHUs 1, 2, 3, 5, 6, 7 and S1. These units will be de-energized at a variable unoccupied time and will be energized before the arrival of the facility occupants the next day. Based on occupancy schedules, ambient conditions and building thermal characteristics, the equipment can be started as late as possible, and stopped as early as possible without sacrificing occupant comfort. By minimizing the equipment operating time in this manner, more energy savings would occur. The units will remain off during the weekend and holidays. When a space temperature becomes too high during the cooling season or too low during the heating season, the units will cycle as required to maintain a preset unoccupied space temperature.

3. In the LSTC building, all multizone units and all single zone units with reheat coils in their branches will have a cooling side discharge air temperature reset. All branch thermostats and zone supply air temperatures downstream of the reheat coils (RH) will be monitored. The cooling coil leaving air temperature will be reset sufficiently to satisfy at least one zone thermostat without reheat or mixing.

4. In the TC-1 building, AH-3, 51, 52, and 53 and will be furnished with all necessary controls

to facilitate an economizer cycle based upon enthalpy control. In appropriate ambient conditions, these units will operate in the economizer mode, which will save thermal cooling energy.

5. In the TC-2 building, the existing local chiller controls including CHW and condenser water temperature reset will be added to a global EMS system.

6. In the LSTC building, the general building exhaust fan EF-2 will be provided with start/stop controls which are programmed to turn the fan off at night and on in the morning. The same EMS controls will be applied to the HW circulation pump, P-5, serving the building's terminal reheat coils.

7. In TC-1, the air handling units, AHU-51, 52 and 53, will be provided with EMS controls which will eliminate the reheating of supply air in order to maintain space temperatures. The new controls will utilize CHW and HW coil control valve sequencing to maintain space temperatures. The EMS will override the normal local controls whenever the space humidity sensors call for dehumidification. Also, the electric humidification units, EH-51 and 53, will be deactivated (with override control) to reduce the need for both humidification and dehumidification in the building.

This project will require engineering design and specification of the HVAC system controls and EMS systems, modifications to some of the existing HVAC controls and installation of the new controls and EMS systems required to perform the previously mentioned functions.

C. Discussion:

Installing an EMS system is intended to coordinate all of the existing controls and to add controls that will not only save HELSTF money but also save in maintaining the equipment. The EMS system will be designed such that the controls operating in the above-mentioned manner can be bypassed to provide design conditions when required.

1. In the LSTC building, the AHU-S1 is a 100% OA unit. This unit is providing OA to AH-1, 2, 3, 5, 6, 7, and 13 at the facility. Currently the AHU is set to deliver 7,846 CFM regardless of the building occupancy level. The existing occupancy level of the facility is 144 people. At a rate of 20 CFM per person, only 2,880 CFM minimum OA is needed to meet current ASHRAE ventilation standards.

   The typical facility room thermostats are set to maintain 70°F. The humidity is generally maintained at 40%. The average return air temperature is estimated at 75°F.

   Generally, the ambient condition in the White Sands area is dry. Therefore, to take full advantage of free cooling, the controls will be adjusted or provided to operate AHU-S1 similar to one with an economizer cycle. However, because there are enough humid days during the year, the economizer cycle will be controlled by using enthalpy conditions as opposed to just dry-bulb conditions.

   In an enthalpy economizer control operation, the amount of outside airflow is determined by which type of air (return or ambient) requires the less work on the compressor while maintaining the minimum amount of required ventilation airflow. Therefore, if the ambient air requires less refrigeration work, as shown on the psychrometric chart, than the return air a maximum amount of ambient air should be used. There is no single set point, but must be determined from the room conditions and leaving coil conditions. A typical value for these

types of systems may be 68°F, and 70% RH.

During the cooling season, when the ambient condition is not conducive to using economizer control, the unit will deliver 2,880 CFM to maintain ventilation requirements. When conditions do permit, the controls will reset to deliver up to 7,846 CFM. This economizer cycle will remain in operation until the ambient air drops below 50°F. Below 50°F ambient temperature, the airflow will reset to 2,880 CFM.

The operation will produce cooling energy savings during the summer season as 4,966 CFM (7,846 CFM - 2,880 CFM) will not require cooling. Similarly, the same quantity of airflow will not require heating below 50°F ambient temperature during the winter season, and heating energy savings will occur.

A 7.5 HP variable frequency drive, necessary hardware and software to monitor the fan output (air volume, air velocity or duct static pressure), and ambient temperature sensors will be required to accomplish the above operation.

2. Currently the LSTC's occupancy hours are from 7:00 a.m. to 4:00 p.m. daily. The building remains unoccupied during the weekends and holidays. These occupancy hours change only when a laser test is conducted at the facility.

Regardless of occupancy hours, all AHUs are operating 24 hours per day, 365 days per year. Depending on occupancy schedules, ambient conditions and building thermal characteristics, AHUs 1, 2, 3, 5, 6 and 7 will be turned off every day in the evening. The equipment will be stopped as early as possible and turned back on as late as possible every weekday without sacrificing occupant comfort. These AHUs will remain off during weekends and holidays.

Several temperature sensors will be installed in the spaces served by these AHUs. These sensors will monitor the space temperature during the unoccupied hours. During the cooling season when the space temperature exceeds 85°F, the AHUs serving that space will energize to cool the space below 85°F. When the space temperature reaches 84°F, these AHUs will cycle off. Similarly, the wintertime unoccupied space temperature will be maintained at 65°F.

The EMS system will have the capability to manually override this operation when special tasks or tests are performed at the facility. All AHUs serving the critical areas and the Liebert-type computer room units will operate as usual, and they will not be included in the new optimum start/stop program. However, if desired, their current operation and performance can be monitored by the new EMS system by adding sensors.

3. Currently all multizone and single zone units in the LSTC building are maintaining cold deck temperatures of 50°F to 55°F. The individual room temperatures are controlled by mixing cold deck air with return air in the multizone AHUs, and by reheating cold deck air with terminal reheat coils in the single zone AHUs. In both cases, energy is wasted. By resetting the cold deck temperatures to a higher temperature, cooling and heating energy savings will occur.

AHUs 1, 2 and 7 are multizone units. Cold deck air temperatures at the units and zone supply air temperatures downstream of the mixing dampers will be monitored. High zone supply air temperatures indicate the mixing of cold deck and return air by the unit's zone mixing dampers. When this occurs in all zones, the cold deck temperature will be increased to minimize mixing. This process will continue until one of the zones requires no mixing. (A

1.0°F differential in these temperatures will be permitted to compensate for mixing damper leakage and heat gain from the ceiling plenum.) The space humidity also will be monitored. When the humidity exceeds its upper limit, the cooling supply air temperature will be decreased to provide dehumidification.

A similar procedure will be followed for single zone AHUs 5, 6 and S-4. These AHUs are equipped with terminal reheat coils in their branch ducts. The coil control valves are modulated by the room thermostats to maintain room temperatures. All branch supply air temperatures will be monitored. The AHU cold deck air temperatures will be increased until one valve for the branch reheat coils is completely closed and the room temperature is maintained without reheat. These units also will have a humidity override control similar to the multizone units.

4. All AHUs serving the TC-1 building are small single zone units. They are equipped with a single CHW and HW reheat coil. These units control respective space temperatures with thermostats that control and modulate CHW and HW coil valves. Outside air (OA) and return air (RA) dampers remain in set positions at all times regardless of outside ambient temperatures. AH-3, 51, 52, and 53 RA, OA, and mixed air (MA) temperatures will be monitored by sensors. When the OA temperature is favorable, (below 65°F), the OA dampers will be modulated open to take full advantage of free cooling. Below 50°F ambient temperature, the reverse procedure will occur, and the OA damper will modulate to the closed position. The RA dampers will modulate proportionally with the OA dampers. Due to the conditions, only dry-bulb ambient temperatures will be monitored.

5. Chillers CH-51 and CH-52 currently are furnished with chilled water and condenser water temperature reset controls. Upon a decrease in ambient temperature, the leaving CHW temperature increases. An increase in leaving CHW temperature decreases the KW/ton which reduces the electrical energy required. The entering condenser water temperature is reduced in certain weather conditions to further enhance the chiller efficiency.

   As the differential pressure between the evaporator and condenser is decreased, the energy required to operate the chiller compressor also decreases. Therefore, reducing the condenser water temperature will save energy. However, the cooling tower fan energy increases to produce a lower condenser water temperature. The EMS system will monitor and activate the reset program when atmospheric conditions permit, and when the energy savings from the chiller compressor exceeds the additional cooling tower fan energy required to produce a lower condenser water temperature.

6. In LSTC, the general exhaust fan EF-2 currently operates 24 hours a day, even when the building is unoccupied. Since the AHU-S1 supplying outside ventilation air to the building will be turned off at night and on weekends as described above, the exhaust fan EF-2 can be turned off during these periods to save energy as well. Also, since the other AHUs in the building will be off at night and on weekends, the HW circulation pump P-5, which serves the terminal reheat coils in the building, can be turned off as well to save energy.

7. In TC-1, the AHUs 51, 52 and 53 currently have controls which maintain cold deck temperatures of 50°F to 55°F for the purposes of dehumidification. The HW reheat coils on these units are then used to maintain space temperatures. At the same time, the electric humidification units, EH-51 and EH-53, are adding humidity to the spaces.

   Since the newer electronics equipment in the building is less sensitive to low humidity than was older electronics equipment, it is felt that the EH-51 and 53 humidifiers can be turned off

without harming the equipment in the conditioned spaces. The electronics equipment manufacturers can be contacted to verify this assumption. This will reduce the excess humidity currently introduced into the space. Since the ambient conditions in the desert are usually dry, the spaces will generally have little need for dehumidification, except for periods when it rains outside. Therefore, most of the time the space thermostats can be used to control the AHU CHW and HW control valves in sequence to maintain space temperatures. This will save cooling energy at the chiller. Whenever the spaces have excessive humidity, such as on rainy days or days of testing that require critical optical paths to be maintained, the EMS can reset the AHUs to the current mode of operation to provide the needed dehumidification or humidification.

These are the only units in the Test Cell # 1 that have controls that maintain cold deck temperatures at a certain set point. AHU-1, 54 and 55 will remain as they currently operate because the coil leaving temperatures are controlled by the space temperature. Therefore, there is no need to include these AHUs with this option because they are currently operating as such.

D. Savings Calculations:

The monthly peak demand and energy consumption of the existing HVAC systems before and after installation of the EMS controls were calculated using the Trace 600 computer program[1]. The LSTC, TC-1 and TC-2 existing HVAC systems were modeled by the computer to provide realistic energy usage profiles for both conditions. However, in order to account for previously derived savings, the lighting systems of ECOs A and B were used as initial conditions in the computer simulations. Field data obtained from the buildings were used to create these computer building models[2].

Once the computer simulations were completed, the total annual demand costs and energy consumptions of the existing and proposed HVAC systems were compared to determine the annual savings from this ECO. These savings calculations are shown on pages B-76 to B-79.

E. Cost Estimate:

The total implementation costs for this ECO were estimated on pages B-80 to B-82. An estimated EMS points list for the buildings included in this ECO is provided on pages B-72 to B-75. This point list was used to produce the estimated ECO implementation cost.

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the program LCCID and data from the above calculations. The summary sheet for the life cycle cost analysis is shown on page B-83. The "Other" fuel type shown in Section # 2 is for diesel fuel consumption. The results of the analysis are listed in the summary on page B-67.

REFERENCES

1. See Appendix G (Volume II, Tab 7) for Trace 600 input and output data for this ECO.

2. See Appendix F (Volume II, Tab 6) for building field data used to create computer models.

| BUILDING NO: | HARDWARE | | | | | | | | | | | | | | | | | | | | | | | | | |
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| LSTC | OUTPUT | | | | | | | | INPUT | | | | | | | | | | | | | | | | | |
| SYSTEM: | DIGITAL | | | | | ANALOG | | | DIGITAL | | | | | | | | | ANALOG | | | | | | | | |
| OCCUPANCY TIME: | | | | | | | | | | | | | | | | | | | | | | | | | | |
| GRAPHIC DISPLAY ● | | | | | | | | | | | | | | | | | | | | | | | | | | |
| POINT DESCRIPTION | START / STOP | OPEN / CLOSED | | | ENABLE / DISABLE | CONTROL VALVE | CONTROL DAMPER | 4-20 MA OUTPUT | PRESSURE SWITCH | DIFFERENTIAL PRESSURE SWITCH | FLOW SWITCH | AUXILIARY CONTACT | PULSE METER | END SWITCH | CURRENT SWITCHING RELAY | | LEVEL | TEMPERATURE F | RELATIVE HUMIDITY % | VOLTS | AMPS | WATTS | GAGE PRESSURE | DIFFERENTIAL PRESSURE | POSITION | [illegible] |
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| W/C CHILLERS ● | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CHILLER CH-1 | | | | | 1 | | | | | | | | | | | | | | | | 1 | | | | | |
| CHW PUMP P-7 | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | | |
| CND PUMP P-10A | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | | |
| CHILLER CH-3 | | | | | 1 | | | | | | | | | | | | | | | | 1 | | | | | |
| CND PUMP P-10B | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | | |
| TWR. FAN CT-1A | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | | |
| TWR. FAN CT-1B | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | | |
| CHW SUPPLY HEADER | | | | | | | | | | | | | | | | | | 2 | | | | | | | | |
| CHW RETURN HEADER | | | | | | | | | | | | | | | | | | 2 | | | | | | | | |
| CND SUPPLY HEADER | | | | | | | | | | | | | | | | | | 2 | | | | | | | | |
| CND RETURN HEADER | | | | | | | | | | | | | | | | | | 2 | | | | | | | | |
| TWR. BYPASS VALVE | | | | | | | | 2 | | | | | | | | | | | | | | | | | | |
| HEAT RECLAIM SYSTEM | | | | | | 2 | | | | | | | | | | | | | | | | | | | | |
| HW PUMP P-5 | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | | |
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| EXHAUST FANS ● | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EF-1 | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | | |
| EF-2 | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | | |
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| AHU1, 2 ● | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 2 | | | | | | | | | | | | | | 2 | | | | | | | | | | | |
| COLD DECK TEMP. | | | | | | 2 | | | | | | | | | | | | 2 | | | | | | | | |
| BYPASS DAMPER | | | | | | | 2 | | | | | | | | | | | | | | | | | | | |
| RETURN AIR | | | | | | | | | | | | | | | | | | 2 | 2 | | | | | | | |
| MIXED AIR | | | | | | | | | | | | | | | | | | 2 | 2 | | | | | | | |
| ZONE DAMPERS | | | | | | | 8 | | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 8 | | | | | | | | |
| FILTER | | | | | | | | | | 2 | | | | | | | | | | | | | | | | |
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| AHU3, 5, 6, S4 ● | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 4 | | | | | | | | | | | | | | 4 | | | | | | | | | | | |
| COLD DECK TEMP. | | | | | | 4 | | | | | | | | | | | | 4 | | | | | | | | |
| RETURN AIR | | | | | | | | | | | | | | | | | | 4 | 4 | | | | | | | |
| MIXED AIR | | | | | | | | | | | | | | | | | | 4 | 4 | | | | | | | |
| ZONE REHEAT VALVE | | | | | | 35 | | | | | | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 35 | | | | | | | | |
| FILTER | | | | | | | | | | 4 | | | | | | | | | | | | | | | | |
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| AHU7 ● | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | | |
| COLD DECK TEMP. | | | | | | 1 | | | | | | | | | | | | 1 | | | | | | | | |
| RETURN AIR | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | | | |
| MIXED AIR | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | | | |
| BYPASS DAMPER | | | | | | | 1 | | | | | | | | | | | | | | | | | | | |
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| ANALOG | | | | | | | ALARMS | | | | | | | APPLICATION PROGRAMS | | | | | | | | | | | | | | | | | | | | | | | | |
| AMPS | WATTS | GAGE PRESSURE | DIFFERENTIAL PRESSURE | POSITION | FLOW | CO2 AND O2 ANALYZERS | STATUS FAILURE | MAINTENANCE FLAG | | HIGH LIMIT | LOW LIMIT | | | SCHEDULED START / STOP | OPTIMUM START / STOP | DUTY CYCLE | DEMAND LIMITING | DAY / NIGHT SETBACK | ECONOMIZER | VENTILATION / RECIRCULATION | HOT / COLD DECK RESET | REHEAT COIL RESET | STEAM BOILER SELECTION | HW BOILER SELECTION | HW OA RESET | CHILLER SELECTION | CHILLED WATER RESET | CONDENSER WATER RESET | CHILLER DEMAND LIMIT | LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH | CFM | GPM | FAILURE MODE | |
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| CHILLED WATER RESET | CONDENSER WATER RESET | CHILLER DEMAND LIMIT | LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH | CFM | GPM | FAILURE MODE | NOTES: |
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| UPPLY FAN | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | | |
| FILTER | | | | | | | | | | 1 | | | | | | | | | | | | | | | | |
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| AHU8, 9, 10, 11A, 11B | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12, 14 ● | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 7 | | | | | | | | | | | | | | 7 | | | | | | | | | | | |
| COOLING COIL | | | | | | 7 | | | | | | | | | | | | 7 | | | | | | | | |
| RETURN AIR | | | | | | | | | | | | | | | | | | 7 | 7 | | | | | | | |
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| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 7 | | | | | | | | |
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| OUTSIDE AIR | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | | | |
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| METERING ● | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ELECTRIC POWER | | | | | | | | | | | | | 1 | | | | | | | | | | | | | |
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| TOTAL AO POINTS = | 25 |
| TOTAL DO POINTS = | 64 |
| TOTAL AI POINTS = | 39 |
| TOTAL DI POINTS = | 123 |
| GRAND TOTAL POINTS = | 251 |

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| OCCUPANCY TIME: | | | | | | | | | | | | | | | | | | | | | | | | | |
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| POINT DESCRIPTION | START / STOP | OPEN / CLOSED | | | ENABLE / DISABLE | CONTROL VALVE | CONTROL DAMPER | 4-20 MA OUTPUT | PRESSURE SWITCH | DIFFERENTIAL PRESSURE SWITCH | FLOW SWITCH | AUXILIARY CONTACT | PULSE METER | END SWITCH | CURRENT SWITCHING RELAY | | LEVEL | TEMPERATURE F | RELATIVE HUMIDITY % | VOLTS | AMPS | WATTS | GAGE PRESSURE | DIFFERENTIAL PRESSURE | POSITION |
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| W/C CHILLERS ● | | | | | | | | | | | | | | | | | | | | | | | | | |
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| CHW PUMP P-51 | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| CND PUMP P-60 | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| CND PUMP P-65 | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| CHILLER CH-52 | | | | | 1 | | | | | | | | | | | | | | | | 1 | | | | |
| CHW PUMP P-52 | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| CND PUMP P-61 | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| CND PUMP P-66 | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| TWR. FAN CT-51A | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| TWR. FAN CT-51B | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| CHW SUPPLY HEADER | | | | | | | | | | | | | | | | | | 2 | | | | | | | |
| CHW RETURN HEADER | | | | | | | | | | | | | | | | | | 2 | | | | | | | |
| CND SUPPLY HEADER | | | | | | | | | | | | | | | | | | 2 | | | | | | | |
| CND RETURN HEADER | | | | | | | | | | | | | | | | | | 2 | | | | | | | |
| TWR. BYPASS VALVE | | | | | | | | 2 | | | | | | | | | | | | | | | | | |
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| HW BOILERS ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOILER B-51 | | | | | 1 | | | | | | | 1 | | | | | | | | | | | | | |
| HW PUMP P-70 | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| HW PUMP P-63 | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
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| HW PUMP P-71 | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| HW PUMP P-64 | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | |
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| AHU-51, 52, 53 ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 3 | | | | | | | | | | | | | | 3 | | | | | | | | | | |
| COLD DECK TEMP. | | | | | | 3 | | | | | | | | | | | | 3 | | | | | | | |
| RETURN AIR | | | | | | | | | | | | | | | | | | 3 | | | | | | | |
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| WATTS | GAGE PRESSURE | DIFFERENTIAL PRESSURE | POSITION | FLOW | CO2 AND O2 ANALYZERS | STATUS FAILURE | MAINTENANCE FLAG | | HIGH LIMIT | LOW LIMIT | | | SCHEDULED START / STOP | OPTIMUM START / STOP | DUTY CYCLE | DEMAND LIMITING | DAY / NIGHT SETBACK | ECONOMIZER | VENTILATION / RECIRCULATION | HOT / COLD DECK RESET | REHEAT COIL RESET | STEAM BOILER SELECTION | HW BOILER SELECTION | HW OA RESET | CHILLER SELECTION | CHILLED WATER RESET | CONDENSER WATER RESET | CHILLER DEMAND LIMIT | LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH | CFM | GPM | FAILURE MODE | |
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| CHILLER SELECTION | CHILLED WATER RESET | CONDENSER WATER RESET | CHILLER DEMAND LIMIT | LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH | CFM | GPM | FAILURE MODE | NOTES: |
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BUILDING NO:

**TC - 1,2**

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| GRAPHIC DISPLAY ● | HARDWARE | | | | | | | | | | | | | | | | | | | | | | | | |
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| | OUTPUT | | | | | | | | INPUT | | | | | | | | | | | | | | | | |
| | DIGITAL | | | | | ANALOG | | | DIGITAL | | | | | | | | | ANALOG | | | | | | | |
| POINT DESCRIPTION | START / STOP | OPEN / CLOSED | | | ENABLE / DISABLE | CONTROL VALVE | CONTROL DAMPER | 4-20 MA OUTPUT | PRESSURE SWITCH | DIFFERENTIAL PRESSURE SWITCH | FLOW SWITCH | AUXILIARY CONTACT | PULSE METER | END SWITCH | CURRENT SWITCHING RELAY | | LEVEL | TEMPERATURE F | RELATIVE HUMIDITY % | VOLTS | AMPS | WATTS | GAGE PRESSURE | DIFFERENTIAL PRESSURE | POSITION |
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| AHU-54, 55 ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 2 | | | | | | | | | | | | | | 2 | | | | | | | | | | |
| COLD DECK TEMP. | | | | | | 2 | | | | | | | | | | | | 2 | | | | | | | |
| RETURN AIR | | | | | | | | | | | | | | | | | | 2 | | | | | | | |
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| AHU-1, 2, 3, 4, 5 ● | | | | | | | | | | | | | | | | | | | | | | | | | |
| SUPPLY FAN | 5 | | | | | | | | | | | | | | 5 | | | | | | | | | | |
| CHW COIL VALVE | | | | | | 5 | | | | | | | | | | | | 5 | | | | | | | |
| HW COIL VALVE | | | | | | 5 | | | | | | | | | | | | 5 | | | | | | | |
| MIXED AIR | | | | | | | | | | | | | | | | | | 5 | | | | | | | |
| RETURN AIR | | | | | | | | | | | | | | | | | | 5 | 5 | | | | | | |
| FILTER | | | | | | | | | | 5 | | | | | | | | | | | | | | | |
| ZONE TEMPERATURE | | | | | | | | | | | | | | | | | | 5 | 5 | | | | | | |
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| OUTSIDE AIR | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | | |
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| METERING ● | | | | | | | | | | | | | | | | | | | | | | | | | |
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TOTAL AO POINTS = 27

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| | | | | | | | | ALARMS | | | | | | | APPLICATION PROGRAMS | | | | | | | | | | | | | | | | | | | | | | | | |
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| [illegible] | AMPS | WATTS | GAGE PRESSURE | DIFFERENTIAL PRESSURE | POSITION | FLOW | CO2 AND O2 ANALYZERS | STATUS FAILURE | MAINTENANCE FLAG | | HIGH LIMIT | LOW LIMIT | | | SCHEDULED START / STOP | OPTIMUM START / STOP | DUTY CYCLE | DEMAND LIMITING | DAY / NIGHT SETBACK | ECONOMIZER | VENTILATION / RECIRCULATION | HOT / COLD DECK RESET | REHEAT COIL RESET | STEAM BOILER SELECTION | HW BOILER SELECTION | HW OA RESET | CHILLER SELECTION | CHILLED WATER RESET | CONDENSER WATER RESET | CHILLER DEMAND LIMIT | LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH | CFM | GPM | FAILURE MODE | |
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2

| ROGRAMS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CHILLER SELECTION | CHILLED WATER RESET | CONDENSER WATER RESET | CHILLER DEMAND LIMIT | LIGHTING CONTROL | REMOTE BOILER CONTROL | RUN TIME | KW | KWH | CFM | GPM | FAILURE MODE | NOTES: |
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3

| ITEM | ECO-C<br>LSTC BUILDING, ECO-B LIGHTING & HVAC SYSTEMS<br>MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 376,570 | |
| Chiller CH-1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 771,420 | |
| Chiller CH-3 | 47.6 | 54.3 | 62.7 | 68.6 | 75.3 | 86.7 | 94.0 | 92.0 | 81.6 | 68.9 | 57.6 | 52.0 | 453,528 | |
| Twr. Fan CT-1A | 0.6 | 0.8 | 1.0 | 3.2 | 7.4 | 12.5 | 12.5 | 12.5 | 12.5 | 4.8 | 0.7 | 0.6 | 25,060 | |
| Twr. Fan CT-1B | 5.3 | 6.2 | 7.1 | 8.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 9.4 | 6.4 | 6.0 | 58,066 | |
| HW pump P-5 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 145,416 | |
| CHW Pump P-7 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 344,268 | |
| CND Pump 10A | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 240,900 | |
| CND Pump 10B | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 160,308 | |
| Fan EF-1 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 10,512 | |
| Fan EF-2 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 23,652 | |
| Fan AH1 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 56,940 | |
| Fan AH2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 89,352 | |
| Fan AH3 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 56,940 | |
| Fan AH5 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 151,548 | |
| Fan AH6 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 121,764 | |
| Fan AH7 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 64,824 | |
| Fan AHS1 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 29,779 | |
| Fan AHS4 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 198,852 | |
| Fan AH-8 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 28,908 | |
| Fan AH-9 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| Fan AH-10 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 15,768 | |
| Fan AH-11A | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 32,412 | |
| Fan AH-11B | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 41,172 | |
| Fan AH-12 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 28,908 | |
| Fan AH-14 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| | | | | | | | | | | | | | | |
| Totals | 458.5 | 466.3 | 475.8 | 485.6 | 498.5 | 515.0 | 522.3 | 520.3 | 509.9 | 488.1 | 469.7 | 463.6 | 3,624,979 | |

Total Energy 12,372 MMBTU/yr (electric)

Total Energy MMBTU/yr (diesel)

| ITEM | ECO-C LSTC BUILDING, PROPOSED LIGHTING & HVAC SYSTEMS MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 376,570 | |
| Chiller CH-1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 491,907 | |
| Chiller CH-3 | 22.5 | 23.5 | 27.9 | 32.3 | 34.5 | 37.0 | 39.3 | 39.1 | 36.9 | 33.1 | 27.9 | 23.6 | 73,212 | |
| Twr. Fan CT-1A | 8.3 | 8.6 | 8.6 | 9.8 | 11.7 | 12.5 | 12.5 | 12.5 | 12.5 | 10.5 | 8.7 | 8.6 | 50,763 | |
| Twr. Fan CT-1B | | | | 3.4 | 7.1 | 10.8 | 10.8 | 10.8 | 10.8 | 4.8 | | | 11,212 | |
| HW pump P-5 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 66,649 | |
| CHW Pump P-7 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 344,268 | |
| CND Pump 10A | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 240,900 | |
| CND Pump 10B | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 50,691 | |
| Fan EF-1 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 4,423 | |
| Fan EF-2 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 9,201 | |
| Fan AH1 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 22,762 | |
| Fan AH2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 39,807 | |
| Fan AH3 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 21,352 | |
| Fan AH5 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 57,644 | |
| Fan AH6 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 48,515 | |
| Fan AH7 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 25,830 | |
| Fan AHS1 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 6,977 | |
| Fan AHS4 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 198,852 | |
| Fan AH-8 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 28,908 | |
| Fan AH-9 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| Fan AH-10 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 15,768 | |
| Fan AH-11A | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 32,412 | |
| Fan AH-11B | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 41,172 | |
| Fan AH-12 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 28,908 | |
| Fan AH-14 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 435.8 | 437.1 | 441.5 | 450.5 | 458.3 | 465.3 | 467.6 | 467.4 | 465.2 | 453.4 | 441.6 | 437.2 | 2,386,815 | |

Energy Savings 4,226 MMBTU/yr (electric)

Energy Savings MMBTU/yr (diesel)

| ITEM | ECO-C<br>TC-1 & TC-2 BUILDINGS, ECO-B LIGHTING & HVAC SYSTEMS<br>MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 356,670 | |
| Chiller CH-51 | 46.6 | 49.2 | 54.7 | 64.5 | 74.9 | 87.3 | 93.5 | 89.1 | 74.8 | 63.3 | 48.9 | 47.4 | 469,708 | |
| Chiller CH-52 | | | | | | | | | | | | | | |
| Twr. Fan CT-51A | 2.6 | 2.8 | 3.0 | 4.2 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 4.4 | 2.7 | 2.6 | 29,520 | |
| Twr. Fan CT-51B | | | | | | | | | | | | | | |
| CHW Pump P-51 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 239,148 | |
| CHW Pump P-52 | | | | | | | | | | | | | | |
| CND Pump P-60 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 115,632 | |
| CND Pump P-61 | | | | | | | | | | | | | | |
| CND Pump P-65 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 195,348 | |
| CND Pump P-66 | | | | | | | | | | | | | | |
| Boiler B-51 | | | | | | | | | | | | | | 19,331 |
| Boiler B-52 | | | | | | | | | | | | | | |
| HW pump P-70 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 23,652 | |
| HW pump P-71 | | | | | | | | | | | | | | |
| HW pump P-63 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 56,064 | |
| HW pump P-64 | | | | | | | | | | | | | | |
| Fan AH-1 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 76,212 | |
| Fan AH-2 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 18,396 | |
| Fan AH-3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 90,228 | |
| Fan AH-4 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 42,924 | |
| Fan AH-5 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 35,916 | |
| Fan AH-51 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 42,924 | |
| Fan AH-52 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 14,892 | |
| Fan AH-53 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 75,336 | |
| Fan AH-54 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 38,544 | |
| Fan AH-55 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 35,916 | |
| | | | | | | | | | | | | | | |
| Totals | 218.3 | 221.1 | 226.8 | 237.8 | 249.3 | 261.7 | 267.9 | 263.5 | 249.2 | 236.8 | 220.7 | 219.1 | 1,957,030 | 19,331 |

| | | |
|---|---|---|
| Total Energy | 6,679 MMBTU/yr | (electric) |
| Total Energy | 1,933 MMBTU/yr | (diesel) |

| ITEM | ECO-C<br>TC-1 & TC-2 BUILDINGS, PROPOSED LIGHTING & HVAC SYSTEMS<br>MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 356,670 | |
| Chiller CH-51 | 37.7 | 38.7 | 49.6 | 56.2 | 63.9 | 71.5 | 76.0 | 74.3 | 66.1 | 56.2 | 38.4 | 38.0 | 400,851 | |
| Chiller CH-52 | | | | | | | | | | | | | | |
| Twr. Fan CT-51A | 4.5 | 4.7 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 5.0 | 4.6 | 42,143 | |
| Twr. Fan CT-51B | | | | | | | | | | | | | | |
| CHW Pump P-51 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 239,148 | |
| CHW Pump P-52 | | | | | | | | | | | | | | |
| CND Pump P-60 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 115,632 | |
| CND Pump P-61 | | | | | | | | | | | | | | |
| CND Pump P-65 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 195,348 | |
| CND Pump P-66 | | | | | | | | | | | | | | |
| Boiler B-51 | | | | | | | | | | | | | | 13,913 |
| Boiler B-52 | | | | | | | | | | | | | | |
| HW pump P-70 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 23,652 | |
| HW pump P-71 | | | | | | | | | | | | | | |
| HW pump P-63 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 56,064 | |
| HW pump P-64 | | | | | | | | | | | | | | |
| Fan AH-1 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 76,212 | |
| Fan AH-2 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 18,396 | |
| Fan AH-3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 90,228 | |
| Fan AH-4 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 42,924 | |
| Fan AH-5 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 35,916 | |
| Fan AH-51 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 42,924 | |
| Fan AH-52 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 14,892 | |
| Fan AH-53 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 75,336 | |
| Fan AH-54 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 38,544 | |
| Fan AH-55 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 35,916 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 211.3 | 212.5 | 224.0 | 230.6 | 238.3 | 245.9 | 250.4 | 248.7 | 240.5 | 230.6 | 212.5 | 211.7 | 1,900,796 | 13,913 |

Energy Savings 192 MMBTU/yr (electric)

Energy Savings 542 MMBTU/yr (diesel)

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - LSTC TEST CELL 1 AND 2 | **PROJECT NO:** 03-0185.05 | **DATE:** 7/24/96

**ECO NO. C** | **BY:** KOTHMAN, K. | **CHECKED BY:** HOWARD, D.

**PROJECT DESCRIPTION:** Install Energy Management System To Control HVAC Equipment

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| EMCS submittals | 1 | job | | | | 5,000.00 | 5,000 | 5,000 |
| Training | 1 | job | | | | 1,000.00 | 1,000 | 1,000 |
| System test & start-up | 1 | job | | | | 5,300.00 | 5,300 | 5,300 |
| The following Point Cost Summary includes common costs and circuits | | | | | | | | |
| Equipment on/off status | 6 | ea | 12.0 | 30.00 | 2,160 | 175.74 | 1,054 | 3,214 |
| Control relay | 46 | ea | 2.0 | 30.00 | 2,760 | 29.00 | 1,334 | 4,094 |
| Control point adjustment | 1 | ea | 14.0 | 30.00 | 420 | 936.12 | 936 | 1,356 |
| Position adjustment | 1 | ea | 14.0 | 30.00 | 420 | 528.96 | 529 | 949 |
| UMCS control actuator | 44 | ea | 13.0 | 30.00 | 17,160 | 405.50 | 17,842 | 35,002 |
| SUBTOTAL FROM PAGE 2 | | | | | 99,630 | | 107,680 | 207,310 |
| SUBTOTAL FROM PAGE 3 | | | | | 2,640 | | 20,791 | 23,431 |
| **SUBTOTAL** | | | | | 125,190 | | 161,466 | 286,656 |
| **O & P @ 20%** | | | | | 25,038 | | 32,293 | 57,331 |
| **SUBTOTAL** | | | | | 150,228 | | 193,759 | 343,987 |
| **DESIGN @ 6%** | | | | | | | | 20,639 |
| **SUBTOTAL** | | | | | | | | 364,626 |
| **SIOH @ 5.5%** | | | | | | | | 20,054 |
| **NMGRT @ 6%** | | | | | | | | 21,878 |
| **AREA ADJUST. @ 10%** | | | | | | | | 36,463 |
| **TOTAL** | | | | | | | | $443,021 |


**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - LSTC AND TEST CELL 1 AND 2

**ECO NO.** C

**PROJECT NO:** 03-0185.05 **DATE:** 7/24/96

**BY :** KOTHMAN, K. **CHECKED BY:** HOWARD, D.

**PROJECT DESCRIPTION:** Install Energy Management System To Control HVAC Equipment

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Differential pressure switch | 25 | ea | 10.0 | 30.00 | 7,500 | 225.00 | 5,625 | 13,125 |
| Auxiliary contact | 2 | ea | 2.0 | 30.00 | 120 | 26.42 | 53 | 173 |
| Current sensor/relay | 46 | ea | 2.0 | 30.00 | 2,760 | 29.00 | 1,334 | 4,094 |
| Temperature sensor/hydronic | 30 | ea | 18.0 | 30.00 | 16,200 | 26.42 | 793 | 16,993 |
| Temperature senosr/space | 123 | ea | 13.0 | 30.00 | 47,970 | 556.00 | 68,388 | 116,358 |
| Temperature sensor flue gas | 2 | ea | 13.0 | 30.00 | 780 | 534.00 | 1,068 | 1,848 |
| Relative Humidity sensor | 43 | ea | 14.0 | 30.00 | 18,060 | 615.00 | 26,445 | 44,505 |
| Flow sensor | 11 | ea | 12.0 | 30.00 | 3,960 | 210.00 | 2,310 | 6,270 |
| Pressure sensor | 4 | ea | 10.0 | 30.00 | 1,200 | 197.00 | 788 | 1,988 |
| AMP/meter/A.I. | 4 | ea | 9.0 | 30.00 | 1,080 | 219.00 | 876 | 1,956 |
| SUBTOTAL PAGE 2 | | | | | 99,630 | | 107,680 | 207,310 |

| | | | | |
|---|---|---|---|---|
| SUBTOTAL | | | | |
| O & P @ 20% | | | | |
| SUBTOTAL | | | | |
| DESIGN @ 6% | | | | |
| SUBTOTAL | | | | |
| SIOH @ 5.5% | | | | |
| NMGRT @ 6% | | | | |
| AREA ADJUST. @ 10% | | | | |
| TOTAL | | | | |


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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: HELSTF - LSTC AND TEST CELL 1 AND 2

ECO NO. C

PROJECT NO: 03-0185.05

DATE: 7/24/96

BY : KOTHMAN, K.

CHECKED BY: HOWARD, D.

PROJECT DESCRIPTION: Install Energy Management System to Control HVAC Equipment

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Electrical metering watts/vars A.1 | 2 | ea | 12.0 | 30.00 | 720 | 440.00 | 880 | 1,600 |
| Operators consol control unit | 1 | ea | | | | 13,184.00 | 13,184 | 13,184 |
| Alarm printer | 1 | ea | | | | 900.00 | 900 | 900 |
| Software included above: | | | | | | | | |
| Communication modem device and remote panel | 2 | ea | 24.0 | 30.00 | 1,440 | 2,500.00 | 5,000 | 6,440 |
| 7-1/2 HP VFD FOR AHU-S1, WITH SP CONTROLER | 1 | EA | 12.0 | 30.00 | 360 | 800.00 | 800 | 1,160 |
| CONTROL CIRCUITS | 1 | EA | 4.0 | 30.00 | 120 | 26.60 | 27 | 147 |
| SUBTOTAL PAGE 3 | | | | | 2,640 | | 20,791 | 23,431 |

| | | | | |
|---|---|---|---|---|
| SUBTOTAL | | | | |
| O & P @ 20% | | | | |
| SUBTOTAL | | | | |
| DESIGN @ 6% | | | | |
| SUBTOTAL | | | | |
| SIOH @ 5.5% | | | | |
| NMGRT @ 6% | | | | |
| AREA ADJUST. @ 10% | | | | |
| TOTAL | | | | |


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Life Cycle Cost Analysis — Study: HELSTF.LC

Energy Conservation Investment Program (ECIP) — LCCID FY96

Installation & Location: WSMR

Region data: NEW MEXICO Census Region: 4

Project NO. & Title: 03-0185.05 EEAP ENERGY STUDY - HELSTF FACILITY

Fiscal Year: 1996 Discrete Portion: ECO-C

Analysis Date: 07/24/96 Economic Life: 20 years

Prepared by: JOHN CARTER

ECIP Summary Report

1. Investment

| | | |
|---|---|---|
| A. | Construction Cost | 402328 |
| B. | SIOH | 20054 |
| C. | Design Cost | 20639 |
| D. | Total Cost (1A+1B+1C) | $443,021 |
| E. | Salvage Value of Existing Equip. | $0 |
| F. | Public Utility Company Rebate | $0 |
| G. | Total Investment (1D-1E-1F) | $443,021 |

2. Energy Savings (+) / Costs (-)

Date of NISTIR 85-3273-X used for Discount Factors Oct 1995

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $25. | /Mbtus | 4,419 | Mbtus | $110,298 | 14.47 | $1,596,016 |
| Elec. Deman | | | | | $0 | 13.47 | $0 |
| Distillate | $. | /Mbtus | 0 | Mbtus | $0 | 17.01 | $0 |
| Residual Oi | $. | /Mbtus | 0 | Mbtus | $0 | 17.23 | $0 |
| Natural Gas | $. | /Mbtus | 0 | Mbtus | $0 | 17.32 | $0 |
| Coal | $. | /Mbtus | 0 | Mbtus | $0 | 14.04 | $0 |
| LPG | $6.5 | /Mbtus | 0 | Mbtus | $0 | 15.64 | $0 |
| Solar | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Geothermal | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Biomass | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Refuse | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Wind | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Other | $7. | /Mbtus | 542 | Mbtus | $3,789 | 13.47 | $51,032 |
| TOTAL | | | 4,961 | Mbtus | $114,087 | | $1,647,048 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

| | | |
|---|---|---|
| 4. | First Year Dollar Savings | $114,087 |
| 5. | Simple Payback Period (Years) | 3.88 |
| 6. | Total Net Discounted Savings | $1,647,048 |
| 7. | Savings to Investment Ratio | 3.72 |
| | If < 1, Project does not qualify | |
| 8 | Adjusted Internal Rate of Return | 11.16% |

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | D |
| DATE: | 5/6/96 |
| ECO TITLE: | VAV Retrofit |
| INSTALLATION: | HELSTF, LSTC Building |
| LOCATION: | White Sands Missile Range, New Mexico |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 1,271 | MMBTU/yr |
| Diesel Energy Savings | 0 | MMBTU/yr |
| Total Energy Savings | 1,271 | MMBTU/yr |
| Total Cost Savings | 31,724 | $/yr |
| Total Investment | 140,835 | $ |
| Simple Payback | 4.44 | yrs |
| SIR | 3.26 | |

B. ECO Description:

Air handling units 1, 2, 3, 5, 6, 7 and S-4 will be converted to Variable Air Volume (VAV) systems. Approximately one hundred twelve (112) VAV air valve retrofit kits with pneumatic thermostats will be installed in the existing duct work to control the room temperatures by varying the volume of air delivered to the rooms. A total of seven (7) Variable Frequency Drives (VFD) with static pressure (SP) controllers will be installed to maintain the duct SP by varying the fan motor speeds. This project will require engineering design drawings and specifications, as well as installation of the new air systems controls.

C. Discussion:

AHUs 1, 2 and 7 are multizone (MZ) units. The zone temperatures are maintained by varying the supply air temperature while maintaining constant airflow. Supply air temperatures are adjusted by mixing cold air and RA at the unit prior to the supply air discharge. This mixing of return air (RA) and cold air wastes the thermal energy required to initially cool the cold deck air stream. The systems, when converted to VAV, will vary the airflow rates to satisfy thermal loads at the VAV box. This will eliminate wasted energy as only the airflow required for the load will be cooled. If the zone flow rates drop to a preset minimum CFM, then the existing cooling coil valve will modulate to a bypass condition which in turn varies the supply air temperature (the zone dampers will be disconnected from the actuators and placed in full-face position). Since the AHU airflow rates will vary under this new control scheme, the fan speeds can be varied to save energy with reduced airflow. VFDs will be installed to control the fan speeds. A constant preset duct pressure will be maintained by SP controllers which will send a signal to control the VFDs. VAV air valve kits similar to the Titus QCV Series[1] will be installed in the ducts to control the air volume to the spaces. A pneumatic room thermostat will also be installed for each VAV retrofit kit to control the air valves. The controllers on the air valves will also be connected to the existing mixing dampers at the AHUs to allow mixing at minimum air flow settings when required.

AHUs 3, 5, 6 and S-4 are single zone constant air volume units with a preset cold supply air temperature. To maintain space temperatures, this cold air is reheated by terminal reheat (RH) coils, controlled by space thermostats. Thermal energy used to produce cold air and the heating water is wasted under this control sequence. With VAV operation, the supply airflow at a constant temperature will be varied to satisfy the thermal load in the space. If the air flow rates drop to a preset

minimum CFM, then the RH coil valve will open and provide heat to satisfy the thermal load. As with the MZ units, only the airflow required for the load will be heated or cooled. The waste of thermal energy will be minimized with this conversion. VAV retrofit kits, thermostats, VFDs, and SP controllers will be utilized as described in the previous MZ unit application. However, the controllers on the air valves will now be connected to the existing terminal RH coil control valves to allow reheating at minimum air flow settings when required.

D. Savings Calculations:

The monthly peak demand and energy consumption of the LSTC's HVAC systems before and after installation of the VAV controls were calculated using the Trace 600 computer program[2]. However, in order to account for previously derived savings, the lighting and HVAC systems from all previous ECOs were used as initial conditions for this ECO. The computer models provided realistic energy usage profiles for both conditions, before and after the VAV controls. Field data obtained from the buildings were used to create these computer building models[3].

Once the computer simulations were completed, the total annual demand costs and energy consumption of the existing and proposed HVAC systems were compared to determine the annual savings from this ECO. These savings calculations are shown on pages B-86 to B-87.

E. Cost Estimate:

The total implementation costs for this ECO were estimated on pages B-88 to B-89. Manufacturers data, on the VAV retrofit kits for the air handling units, is included in Appendix E (Volume II, Tab 5). This data was used to produce the estimated ECO implementation cost.

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the program LCCID and data from the above calculations. The summary sheet for the life cycle cost analysis is shown on page B-90. The "Other" fuel type shown in Section # 2 is for diesel fuel consumption. The results of the analysis are listed in the summary on page B-84.

## REFERENCES

1. See Appendix E (Volume II, Tab 5) for manufacturer's data on retrofit kits.

2. See Appendix G (Volume II, Tab 7) for Trace 600 input and output data for this ECO.

3. See Appendix F (Volume II, Tab 6) for building field data used to create computer models.

| ITEM | ECO-D LSTC BUILDING, ECO-C LIGHTING & HVAC SYSTEMS MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 376,570 | |
| Chiller CH-1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 491,907 | |
| Chiller CH-3 | 22.5 | 23.5 | 27.9 | 32.3 | 34.5 | 37.0 | 39.3 | 39.1 | 36.9 | 33.1 | 27.9 | 23.6 | 73,212 | |
| Twr. Fan CT-1A | 8.3 | 8.6 | 8.6 | 9.8 | 11.7 | 12.5 | 12.5 | 12.5 | 12.5 | 10.5 | 8.7 | 8.6 | 50,763 | |
| Twr. Fan CT-1B | | | | 3.4 | 7.1 | 10.8 | 10.8 | 10.8 | 10.8 | 4.8 | | | 11,212 | |
| HW pump P-5 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 66,649 | |
| CHW Pump P-7 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 344,268 | |
| CND Pump 10A | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 240,900 | |
| CND Pump 10B | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 50,691 | |
| Fan EF-1 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 4,423 | |
| Fan EF-2 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 9,201 | |
| Fan AH1 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 22,762 | |
| Fan AH2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 39,807 | |
| Fan AH3 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 21,352 | |
| Fan AH5 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 17.3 | 57,644 | |
| Fan AH6 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 48,515 | |
| Fan AH7 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 25,830 | |
| Fan AHS1 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 6,977 | |
| Fan AHS4 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 22.7 | 198,852 | |
| Fan AH-8 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 28,908 | |
| Fan AH-9 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| Fan AH-10 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 15,768 | |
| Fan AH-11A | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 32,412 | |
| Fan AH-11B | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 41,172 | |
| Fan AH-12 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 28,908 | |
| Fan AH-14 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| | | | | | | | | | | | | | | |
| Totals | 435.8 | 437.1 | 441.5 | 450.5 | 458.3 | 465.3 | 467.6 | 467.4 | 465.2 | 453.4 | 441.6 | 437.2 | 2,386,815 | |

Total Energy 8,146 MMBTU/yr (electric)

Total Energy MMBTU/yr (diesel)

| ITEM | ECO-D LSTC BUILDING, PROPOSED LIGHTING & HVAC SYSTEMS MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 376,570 | |
| Chiller CH-1 | 84.7 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 412,735 | |
| Chiller CH-3 | | 22.5 | 23.5 | 27.4 | 30.4 | 32.0 | 33.4 | 33.2 | 31.6 | 29.4 | 23.3 | 22.5 | 36,776 | |
| Twr. Fan CT-1A | 8.5 | 8.7 | 8.9 | 9.9 | 11.8 | 12.5 | 12.5 | 12.5 | 12.5 | 10.6 | 8.8 | 8.7 | 46,726 | |
| Twr. Fan CT-1B | | | | 1.8 | 6.3 | 10.8 | 10.8 | 10.8 | 10.8 | 3.7 | | | 7,704 | |
| HW pump P-5 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 66,649 | |
| CHW Pump P-7 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 344,268 | |
| CND Pump 10A | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 240,900 | |
| CND Pump 10B | | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 32,080 | |
| Fan EF-1 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 4,423 | |
| Fan EF-2 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 10,031 | |
| Fan AH1 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 22,280 | |
| Fan AH2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 39,733 | |
| Fan AH3 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 15,207 | |
| Fan AH5 | 5.0 | 10.1 | 10.1 | 14.1 | 17.2 | 17.2 | 17.2 | 17.2 | 17.2 | 14.1 | 10.1 | 10.1 | 25,319 | |
| Fan AH6 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 38,539 | |
| Fan AH7 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 25,459 | |
| Fan AHS1 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 5,593 | |
| Fan AHS4 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 18,054 | |
| Fan AH-8 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 28,908 | |
| Fan AH-9 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| Fan AH-10 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 15,768 | |
| Fan AH-11A | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 32,412 | |
| Fan AH-11B | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 41,172 | |
| Fan AH-12 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 28,908 | |
| Fan AH-14 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 378.7 | 428.2 | 429.4 | 440.1 | 452.6 | 459.4 | 460.8 | 460.6 | 459.0 | 444.7 | 429.1 | 428.2 | 2,014,326 | |

Energy Savings 1,271 MMBTU/yr (electric)

Energy Savings MMBTU/yr (diesel)

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - LSTC

**ECO NO.** D

**PROJECT NO:** 03-0185.05 **DATE:** 7/24/96

**BY :** KOTHMAN, K. **CHECKED BY:** HOWARD, D.

**PROJECT DESCRIPTION:** VAV CONTROLS RETROFIT

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Install variable frequency drive and static pressure controller | | | | | | | | |
| on existing air handling unit (3ph 480v) | | | | | | | | |
| 10ph | 2 | ea | 10.7 | 24.62 | 527 | 857.00 | 1,714 | 2,241 |
| 15 hp | 2 | ea | 11.0 | 24.62 | 542 | 905.00 | 1,810 | 2,352 |
| 25 hp | 2 | ea | 13.8 | 24.62 | 680 | 1,140.00 | 2,280 | 2,960 |
| 40 ph | 1 | ea | 16.0 | 24.62 | 394 | 2,550.00 | 2,550 | 2,944 |
| Remove pneumatic t-stat | 43 | ea | 1.0 | 22.91 | 985 | | | 985 |
| Install new pneumatic t-stat | 112 | ea | 1.5 | 24.62 | 4,136 | 136.00 | 15,232 | 19,368 |
| Test and balance | 1 | job | 160.0 | 24.00 | 3,840 | | | 3,840 |
| SUBTOTAL FROM PAGE 2 | | | | | 20,688 | | 35,750 | 56,438 |
| SUBTOTAL | | | | | 31,792 | | 59,336 | 91,128 |
| O & P @ 20% | | | | | 6,358 | | 11,867 | 18,225 |
| SUBTOTAL | | | | | 38,150 | | 71,203 | 109,353 |
| DESIGN @ 6% | | | | | | | | 6,561 |
| SUBTOTAL | | | | | | | | 115,914 |
| SIOH @ 5.5% | | | | | | | | 6,375 |
| NMGRT @ 6% | | | | | | | | 6,955 |
| AREA ADJUST. @ 10% | | | | | | | | 11,591 |
| TOTAL | | | | | | | | $140,835 |


**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: HELSTF - LSTC | PROJECT NO: 03-0185.05 | DATE: 7/24/96

ECO NO. D | BY : KOTHMAN, K. | CHECKED BY: HOWARD, D.

PROJECT DESCRIPTION: VAV CONTROLS RETROFIT .

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Retrofit variable volume terminal | | | | | | | | |
| Size B to 300 CFM | 26 | ea | 2.5 | 22.91 | 1,489 | 235.00 | 6,110 | 7,599 |
| Size C 200 to 400 CFM | 20 | ea | 3.0 | 22.91 | 1,375 | 235.00 | 4,700 | 6,075 |
| Size D 350 to 700 CFM | 18 | 5 | 3.0 | 22.91 | 1,237 | 240.00 | 4,320 | 5,557 |
| Size E 500 to 1000 CFM | 12 | ea | 3.5 | 22.91 | 962 | 250.00 | 3,000 | 3,962 |
| Size J 1000 to 2400 CFM | 16 | ea | 3.5 | 22.91 | 1,283 | 275.00 | 4,400 | 5,500 |
| Size M 1800 to 5400 CFM | 12 | ea | 4.0 | 22.91 | 1,100 | 280.00 | 3,360 | 4,047 |
| Size P 4000 to 10000 CFM | 6 | ea | 5.0 | 22.91 | 687 | 300.00 | 1,800 | 2,487 |
| Size R 5000 to 15000 CFM | 2 | ea | 6.0 | 22.91 | 275 | 390.00 | 780 | 1,055 |
| Misc pneumatic piping and connect | 112 | ea | 3.5 | 22.91 | 8,981 | 60.00 | 6,720 | 15,701 |
| Remove/replace/repair ceiling as required | 1 | job | 144.0 | 22.91 | 3,299 | 560.00 | 560 | 3,859 |
| SUBTOTAL PAGE 2 | | | | | 20,688 | | 35,750 | 56,438 |

| | | | | |
|---|---|---|---|---|
| SUBTOTAL | | | | |
| O & P @ 20% | | | | |
| SUBTOTAL | | | | |
| DESIGN @ 6% | | | | |
| SUBTOTAL | | | | |
| SIOH @ 5.5% | | | | |
| NMGRT @ 6% | | | | |
| AREA ADJUST. @ 10% | | | | |
| TOTAL | | | | |

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Life Cycle Cost Analysis    Study: HELSTF.LC
Energy Conservation Investment Program (ECIP)    LCCID FY96
Installation & Location: WSMR
Region data: NEW MEXICO    Census Region: 4
Project NO. & Title: 03-0185.05 EEAP ENERGY STUDY - HELSTF FACILITY
Fiscal Year: 1996 Discrete Portion: ECO-D
Analysis Date: 07/24/96 Economic Life: 20 years
Prepared by: JOHN CARTER

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | 127899 |
| B. SIOH | 6375 |
| C. Design Cost | 6561 |
| D. Total Cost (1A+1B+1C) | $140,835 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $140,835 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1995

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $25. | /Mbtus | 1,271 | Mbtus | $31,724 | 14.47 | $459,049 |
| Elec. Deman | | | | | $0 | 13.47 | $0 |
| Distillate | $. | /Mbtus | 0 | Mbtus | $0 | 17.01 | $0 |
| Residual Oi | $. | /Mbtus | 0 | Mbtus | $0 | 17.23 | $0 |
| Natural Gas | $. | /Mbtus | 0 | Mbtus | $0 | 17.32 | $0 |
| Coal | $. | /Mbtus | 0 | Mbtus | $0 | 14.04 | $0 |
| LPG | $6.5 | /Mbtus | 0 | Mbtus | $0 | 15.64 | $0 |
| Solar | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Geothermal | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Biomass | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Refuse | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Wind | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Other | $7. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| TOTAL | | | 1,271 | Mbtus | $31,724 | | $459,049 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

| | |
|---|---|
| 4. First Year Dollar Savings | $31,724 |
| 5. Simple Payback Period (Years) | 4.44 |
| 6. Total Net Discounted Savings | $459,049 |
| 7. Savings to Investment Ratio | 3.26 |
| (If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 10.44% |

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | E |
| DATE: | 5/6/96 |
| ECO TITLE: | Provide Energy Efficient Motors |
| INSTALLATION: | HELSTF |
| LOCATION: | White Sands Missile Range, New Mexico |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 357 | MMBTU/yr |
| Diesel Energy Savings | 0 | MMBTU/yr |
| Total Energy Savings | 357 | MMBTU/yr |
| Total Cost Savings | 8,911 | $/yr |
| Total Investment | 52,406 | $ |
| Simple Payback | 5.88 | yrs |
| SIR | 2.46 | |

B. ECO Description:

Replace approximately forty seven (47) motors serving pumps and fans in various areas of the LSTC, TC-1 and TC-2 buildings. The motors shall be the energy efficient type as shown on the proposed motor replacement list, pages B-93 to B-96. Motors serving equipment which is utilized as a backup system should not be replaced, as operational hours are too low to generate substantial savings. This ECO will require the removal of the existing motors and connection to the existing wiring.

C. Discussion:

The existing fans and pumps in the LSTC, TC-1, and TC-2 buildings utilize standard efficiency motors. The newer technology energy efficient motors produce an equivalent horsepower output with a lower power input. A comparison of the new high efficiency motors available is shown on page B-97. In all cases, the new motor type with the lowest KW was chosen to replace the existing motor. Since this retrofit will reduce the building motor load, there will be a savings in HVAC cooling energy, and a penalty in heating energy.

D. Savings Calculations:

The monthly peak demand and energy consumption of the existing motors were calculated using the Trace 600 computer program.[1] LSTC, TC-1, and TC-2 motors were modeled by the computer to provide a realistic energy usage profile. However, in order to account for previously derived savings, the HVAC and lighting systems from all previous ECOs were used as initial conditions. Field data obtained from the buildings was used to create these computer building models.[2]

The monthly peak demand and energy consumption of the proposed motor replacements were calculated using the Trace 600 computer program. LSTC, TC-1, and TC-2 motor replacements were modeled by the computer to provide a new energy usage profile. Equipment lists of the motor replacements used to create these computer building models are shown on pages B-93 to B-96.

Once the computer simulations were completed, the total annual demand costs and energy

consumptions of the existing motors and proposed motor replacements were compared to determine the annual savings from this ECO. These savings calculations are shown on pages B-98 to B-101.

E. Cost Estimate:

The total implementation costs for this ECO were estimated on pages B-102 to B-104. Manufacturer's data on the new high efficiency motors is included in Appendix E (Volume II, Tab 5). This data was used to help produce the cost estimate.

F. Life Cycle Cost Analysis.

A life cycle cost analysis was performed on this ECO using the program LCCID and data from the above calculations. The summary sheet for the life cycle cost analysis is shown on page B-105. The "Other" fuel type shown in Section # 2 is for diesel fuel consumption. The results of the analysis are listed in the project summary on page B-91.

## REFERENCES

1. See Appendix G (Volume II, Tab 7) for computer model input assumptions and data, and energy consumption output data.
2. See Appendix F (Volume II, Tab 6) for building field data and existing lighting system data.

PROPOSED MOTOR REPLACEMENT LIST FOR: HELSTF - LSTC

ECO NO. E: Replace Existing Standard Effiecient Motors with Energy Efficient Motors

| ITEM | QTY | DESCRIPTION | AREA SERVED | HP | PHASE | NAMEPLATE | | | | ACTUAL | | % LOAD | KW DEMAND | KVA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | VOLTS | AMPS | PF | EFF | VOLTS | AMPS | | | |
| P-5 | 1 | Heating Water Pump | LSTC | 25 | 3 | 460 | 29.0 | 0.885 | 93.0% | 460 | 22.3 | 76.9% | 15.7 | 17.8 |
| P-7 | 1 | Chilled Water Pump | LSTC | 60 | 3 | 460 | 67.0 | 0.905 | 94.1% | 460 | 53.9 | 80.5% | 38.9 | 42.9 |
| P-10A | 1 | Condenser Water Pump | CH-1 | 30 | 3 | 460 | 34.0 | 0.905 | 93.0% | 460 | 34.4 | 101.3% | 24.8 | 27.4 |
| P-10B | 1 | Condenser Water Pump | CH-3 | 30 | 3 | 460 | 34.0 | 0.905 | 93.0% | 460 | 24.5 | 72.2% | 17.7 | 19.5 |
| CT-1A | 1 | Cooling Tower | CH-1 | 15 | 3 | 460 | 18.0 | 0.880 | 91.7% | 460 | 17.1 | 94.9% | 12.0 | 13.6 |
| CT-1B | 1 | Cooling Tower | CH-3 | 15 | 3 | 460 | 18.0 | 0.880 | 91.7% | 460 | 14.8 | 82.1% | 10.4 | 11.8 |
| EF-1 | 1 | Exhaust Fan | Battery Room | 1.5 | 3 | 460 | 2.0 | 0.857 | 84.0% | 460 | 1.6 | 80.0% | 1.1 | 1.3 |
| EF-2 | 1 | Exhaust Fan | LSTC | 3 | 3 | 460 | 3.8 | 0.855 | 86.5% | 460 | 3.5 | 90.9% | 2.4 | 2.8 |
| AHU-1 | 1 | Air Handling Unit w/ Hot Water Heating Coil | Basement | 10 | 3 | 460 | 12.4 | 0.850 | 91.0% | 460 | 8.8 | 70.9% | 6.0 | 7.0 |
| AHU-2 | 1 | Air Handling Unit w/ Hot Water Heating Coil | Basement | 15 | 3 | 460 | 18.0 | 0.880 | 91.7% | 460 | 13.8 | 76.9% | 9.7 | 11.0 |
| AHU-3 | 1 | Air Handling Unit w/ Hot Water Heating Coil | Optical Areas | 10 | 3 | 460 | 12.4 | 0.850 | 91.0% | 460 | 8.8 | 70.9% | 6.0 | 7.0 |
| AHU-5 | 1 | Air Handling Unit w/ Hot Water Heating Coil | Main Floor | 25 | 3 | 460 | 29.0 | 0.885 | 93.0% | 460 | 23.5 | 80.9% | 16.6 | 18.7 |
| AHU-6 | 1 | Air Handling Unit w/ Hot Water Heating Coil | Main Floor Domes | 25 | 3 | 460 | 29.0 | 0.885 | 93.0% | 460 | 18.8 | 64.7% | 13.3 | 15.0 |
| AHU-7 | 1 | Air Handling Unit w/ Hot Water Heating Coil | Main Floor Dome | 15 | 3 | 460 | 18.0 | 0.880 | 91.7% | 460 | 10.3 | 57.0% | 7.2 | 8.2 |
| AHU-S1 | 1 | Air Handling Unit w/ Hot Water Heating Coil | LSTC - Outside Air | 7.5 | 3 | 460 | 9.4 | 0.865 | 89.5% | 460 | 5.6 | 60.0% | 3.9 | 4.5 |
| AHU-S4 | 1 | Air Handling Unit w/ Hot Water Heating Coil | Computer Room Under Floor | 40 | 3 | 460 | 45.5 | 0.895 | 93.0% | 460 | 31.3 | 68.8% | 22.3 | 24.9 |
| AHU-8 | 1 | Air Handling Unit | Room 119 | 5 | 3 | 460 | 6.3 | 0.890 | 85.5% | 460 | 4.4 | 70.4% | 3.1 | 3.5 |
| AHU-9 | 1 | Air Handling Unit | Room 119A | 7.5 | 3 | 460 | 9.4 | 0.865 | 89.5% | 460 | 7.3 | 77.3% | 5.0 | 5.8 |
| AHU-10 | 1 | Air Handling Unit | Room 123 | 2 | 3 | 460 | 2.6 | 0.857 | 84.0% | 460 | 2.5 | 96.8% | 1.7 | 2.0 |

PROPOSED MOTOR REPLACEMENT LIST FOR: HELSTF - LSTC

ECO NO. E: Replace Existing Standard Effiecient Motors with Energy Efficient Motors

| ITEM | QTY | DESCRIPTION | AREA SERVED | HP | PHASE | NAMEPLATE | | | | ACTUAL | | % | KW | KVA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | VOLTS | AMPS | PF | EFF | VOLTS | AMPS | LOAD | DEMAND | |
| AHU-11A | 1 | Air Handling Unit | Room 127A | 5 | 3 | 460 | 6.3 | 0.890 | 85.5% | 460 | 4.9 | 77.5% | 3.5 | 3.9 |
| AHU-11B | 1 | Air Handling Unit | Room 127A | 5 | 3 | 460 | 6.3 | 0.890 | 85.5% | 460 | 6.2 | 98.6% | 4.4 | 4.9 |
| AHU-12 | 1 | Air Handling Unit | Room 127 | 5 | 3 | 460 | 6.3 | 0.890 | 85.5% | 460 | 4.4 | 70.4% | 3.1 | 3.5 |
| AHU-14 | 1 | Air Handling Unit | Room 128 | 7.5 | 3 | 460 | 9.4 | 0.865 | 89.5% | 460 | 7.3 | 77.3% | 5.0 | 5.8 |
| Total | | | | | | | | 0.890 | | | | | 233.8 | 262.8 |

PROPOSED MOTOR REPLACEMENT LIST FOR: HELSTF - TEST CELL 1

ECO NO. E: Replace Existing Standard Effiecient Motors with Energy Efficient Motors

| ITEM | QTY | DESCRIPTION | AREA SERVED | HP | PHASE | NAMEPLATE | | | | ACTUAL | | % LOAD | KW DEMAND | KVA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | VOLTS | AMPS | PF | EFF | VOLTS | AMPS | | | |
| AH-1 | 1 | Air Handling Unit | Optics Room | 10 | 3 | 200 | 27.8 | 0.850 | 91.0% | 208 | 25.5 | 91.7% | 7.8 | 9.2 |
| AH-2 | 1 | Air Handling Unit | P.T. Tower | 3 | 3 | 460 | 3.8 | 0.855 | 86.5% | 460 | 3.0 | 77.8% | 2.0 | 2.4 |
| AH-3 | 1 | Air Handling Unit - Supply Fan | P.T. Tower, 201, 301, 401 | 10 | 3 | 460 | 12.4 | 0.850 | 91.0% | 480 | 9.7 | 78.0% | 6.9 | 8.1 |
| | 1 | Air Handling Unit - Return Fan | | 5 | 3 | 460 | 6.3 | 0.890 | 85.5% | 480 | 4.1 | 65.3% | 3.0 | 3.4 |
| AH-4 | 1 | Air Handling Unit - Supply Fan | North Optics - 101 South Optics - 102 | 5 | 3 | 460 | 6.3 | 0.890 | 85.5% | 480 | 4.5 | 72.2% | 3.3 | 3.7 |
| | 1 | Air Handling Unit - Return Fan | | 2 | 3 | 460 | 2.6 | 0.857 | 84.0% | 480 | 1.9 | 71.9% | 1.4 | 1.6 |
| AH-5 | 1 | Air Handling Unit | BTA Room 105 | 7.5 | 3 | 460 | 9.4 | 0.865 | 89.5% | 480 | 5.8 | 61.2% | 4.2 | 4.8 |
| AH-51 | 1 | Air Handling Unit | Device Room 104 | 7.5 | 3 | 460 | 9.4 | 0.865 | 89.5% | 460 | 7.1 | 75.0% | 4.9 | 5.7 |
| AH-52 | 1 | Air Handling Unit | ETA Control Room | 3 | 3 | 460 | 3.8 | 0.855 | 86.5% | 460 | 2.1 | 55.6% | 1.4 | 1.7 |
| AH-53 | 1 | Air Handling Unit | Optics Room 102 | 15 | 3 | 460 | 18.0 | 0.880 | 91.7% | 480 | 11.6 | 64.3% | 8.5 | 9.6 |
| AH-54 | 1 | Air Handling Unit | Optics Elect. Room 109 | 7.5 | 3 | 460 | 9.4 | 0.865 | 89.5% | 480 | 6.1 | 65.0% | 4.4 | 5.1 |
| AH-55 | 1 | Air Handling Unit | Optics Elect. Room 201 | 7.5 | 3 | 460 | 9.4 | 0.865 | 89.5% | 480 | 5.1 | 54.5% | 3.7 | 4.2 |
| TOTAL | | | | | | | | 0.866 | | | | | 51.5 | 59.5 |

PROPOSED MOTOR REPLACEMENT LIST FOR: HELSTF - TEST CELL #2

ECO NO. E: Replace Existing Standard Effecient Motors with Energy Efficient Motors

| ITEM | QTY | DESCRIPTION | AREA SERVED | HP | PHASE | NAMEPLATE | | | | ACTUAL | | % LOAD | KW DEMAND | KVA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | VOLTS | AMPS | PF | EFF | VOLTS | AMPS | | | |
| CT-51A | 1 | Cooling Tower | CH-51 & CH-52 | 7.5 | 3 | 460 | 9.4 | 0.865 | 89.5% | 460 | 6.8 | 72.7% | 4.7 | 5.4 |
| CT-51B | 1 | Cooling Tower | CH-51 & CH-52 | 7.5 | 3 | 460 | 9.4 | 0.865 | 89.5% | 460 | 6.8 | 72.7% | 4.7 | 5.4 |
| P-51 | 1 | Chilled Water Pump | CH-51 | 40 | 3 | 460 | 45.5 | 0.895 | 93.0% | 475 | 36.4 | 80.0% | 26.8 | 29.9 |
| P-52 | 1 | Chilled Water Pump | CH-52 | 40 | 3 | 460 | 45.5 | 0.895 | 93.0% | 475 | 38.2 | 84.0% | 28.1 | 31.4 |
| P-60 | 1 | Condenser Water Pump | CH-51 | 15 | 3 | 460 | 18.0 | 0.880 | 91.7% | 475 | 18.0 | 100.0% | 13.0 | 14.8 |
| P-61 | 1 | Condenser Water Pump | CH-52 | 15 | 3 | 460 | 18.0 | 0.880 | 91.7% | 475 | 14.6 | 81.1% | 10.6 | 12.0 |
| P-63 | 1 | Heating Water Pump | B-51 | 7.5 | 3 | 460 | 9.4 | 0.865 | 89.5% | 475 | 8.9 | 95.0% | 6.3 | 7.3 |
| P-64 | 1 | Heating Water Pump | B-52 | 7.5 | 3 | 460 | 9.4 | 0.865 | 89.5% | 475 | 10.0 | 106.8% | 7.1 | 8.2 |
| P-65 | 1 | Condenser Water Pump | CT-51A/B | 30 | 3 | 460 | 34.0 | 0.905 | 93.0% | 460 | 30.0 | 88.1% | 21.6 | 23.9 |
| P-66 | 1 | Condenser Water Pump | CT-51A/B | 30 | 3 | 460 | 34.0 | 0.905 | 93.0% | 460 | 30.0 | 88.1% | 21.6 | 23.9 |
| P-70 | 1 | Heating Water Pump | B-51 | 3 | 3 | 460 | 3.8 | 0.855 | 86.5% | 475 | 3.3 | 87.0% | 2.3 | 2.7 |
| P-71 | 1 | Heating Water Pump | B-52 | 3 | 3 | 460 | 3.8 | 0.855 | 86.5% | 475 | 3.3 | 87.0% | 2.3 | 2.7 |
| TOTAL | | | | | | | | 0.890 | | | | | 149.1 | 167.6 |

# MOTOR COMPARISON TABLE (1)

| HP | TYPE | ENCL | MAGNETEK CAT. NO. | LIST PRICE (2) | RPM | VOLTS | FRAME | RATED FLA | EFF | PF | CALC FLA (3) | CALC KVA (4) | CALC KW (5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.5 | STANDARD | TEFC | H274 | $230 | 1800 | 460 | JA56 | 0.90 | ? | 0.800 | | 0.72 | 0.57 |
| 0.5 | PREMIUM | TEFC | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 0.5 | VAV | DRIP PF | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 0.5 | E-PLUS III | TEFC | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 0.5 | E-PLUS | TEFC | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 0.75 | STANDARD | TEFC | H580 | $252 | 1800 | 460 | KA56 | 1.20 | ? | 0.800 | | 0.96 | 0.76 |
| 0.75 | PREMIUM | TEFC | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 0.75 | VAV | DRIP PF | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 0.75 | E-PLUS III | TEFC | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 0.75 | E-PLUS | TEFC | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1 | STANDARD | TEFC | T164 | $210 | 1800 | 460 | 143T | 1.80 | 68.0% | 0.780 | 1.77 | 1.41 | 1.10 |
| 1 | PREMIUM | TEFC | S107 | $289 | 1800 | 460 | 143T | 1.60 | 78.5% | 0.780 | 1.53 | 1.22 | 0.95 |
| 1 | VAV | DRIP PF | E188 | $360 | 1800 | 460 | N143T | 1.40 | 82.5% | 0.840 | 1.35 | 1.08 | 0.90 |
| 1 | E-PLUS III | TEFC | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| ***1*** | ***E-PLUS*** | ***TEFC*** | ***E120*** | ***$342*** | ***1800*** | ***460*** | ***L143T*** | ***1.35*** | ***82.5%*** | ***0.840*** | ***1.35*** | ***1.08*** | ***0.90*** |
| 1.5 | STANDARD | TEFC | T165 | $227 | 1800 | 460 | 145T | 2.50 | 74.0% | 0.780 | 2.43 | 1.94 | 1.51 |
| 1.5 | PREMIUM | TEFC | S108 | $302 | 1800 | 460 | 143T | 2.20 | 81.5% | 0.800 | 2.15 | 1.72 | 1.37 |
| 1.5 | VAV | DRIP PF | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1.5 | E-PLUS III | TEFC | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| ***1.5*** | ***E-PLUS*** | ***TEFC*** | ***E121*** | ***$374*** | ***1800*** | ***460*** | ***M145T*** | ***1.95*** | ***84.0%*** | ***0.857*** | ***1.95*** | ***1.55*** | ***1.33*** |
| 2 | STANDARD | TEFC | T166 | $246 | 1800 | 460 | 145T | 3.40 | 74.0% | 0.750 | 3.37 | 2.69 | 2.02 |
| 2 | PREMIUM | TEFC | S109 | $323 | 1800 | 460 | 145T | 3.00 | 81.5% | 0.780 | 2.95 | 2.35 | 1.83 |
| ***2*** | ***VAV*** | ***DRIP PF*** | ***E281*** | ***$431*** | ***1800*** | ***460*** | ***P145T*** | ***2.60*** | ***84.0%*** | ***0.857*** | ***2.60*** | ***2.07*** | ***1.78*** |
| 2 | E-PLUS III | TEFC | N/A | N/A | N/A | N/A | N/A | N/A | N/A | | N/A | N/A | N/A |
| 2 | E-PLUS | TEFC | E122 | $408 | 1800 | 460 | M145T | 2.65 | 84.0% | 0.841 | 2.65 | 2.11 | 1.78 |
| 3 | STANDARD | TEFC | N270 | $405 | 1800 | 460 | 182T | 4.40 | 81.5% | 0.835 | 4.13 | 3.29 | 2.75 |
| 3 | PREMIUM | TEFC | S204 | $383 | 1800 | 460 | 182T | 4.40 | 85.5% | 0.755 | 4.35 | 3.47 | 2.62 |
| 3 | VAV | DRIP PF | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 3 | E-PLUS III | TEFC | E253 | $477 | 1800 | 460 | 182T | 3.90 | 88.5% | 0.855 | 3.71 | 2.96 | 2.53 |
| ***3*** | ***E-PLUS*** | ***TEFC*** | ***E220*** | ***$443*** | ***1800*** | ***460*** | ***S182T*** | ***3.80*** | ***86.5%*** | ***0.855*** | ***3.80*** | ***3.03*** | ***2.59*** |
| 5 | STANDARD | TEFC | N280 | $451 | 1800 | 460 | 184T | 7.00 | 82.5% | 0.835 | 6.80 | 5.41 | 4.52 |
| 5 | PREMIUM | TEFC | S205 | $453 | 1800 | 460 | 184T | 6.70 | 85.5% | 0.820 | 6.68 | 5.32 | 4.36 |
| ***5*** | ***VAV*** | ***DRIP PF*** | ***E281*** | ***$483*** | ***1800*** | ***460*** | ***E184T*** | ***6.30*** | ***85.5%*** | ***0.890*** | ***6.15*** | ***4.90*** | ***4.36*** |
| 5 | E-PLUS III | TEFC | E256 | $550 | 1800 | 460 | 184T | 6.00 | 89.5% | 0.880 | 5.94 | 4.74 | 4.17 |
| 5 | E-PLUS | TEFC | E221 | $511 | 1800 | 460 | L184T | 6.40 | 86.5% | 0.880 | 6.15 | 4.90 | 4.31 |
| 7.5 | STANDARD | TEFC | N370 | $646 | 1800 | 460 | 213T | 9.80 | 86.5% | 0.830 | 9.78 | 7.79 | 6.47 |
| 7.5 | PREMIUM | TEFC | S303 | $919 | 1800 | 460 | 213T | 9.50 | 87.5% | 0.821 | 9.78 | 7.79 | 6.39 |
| ***7.5*** | ***VAV*** | ***DRIP PF*** | ***E380*** | ***$709*** | ***1800*** | ***460*** | ***D213T*** | ***9.40*** | ***89.5%*** | ***0.865*** | ***9.07*** | ***7.23*** | ***6.25*** |
| 7.5 | E-PLUS III | TEFC | E351 | $748 | 1800 | 460 | 213T | 9.40 | 91.0% | 0.845 | 9.13 | 7.28 | 6.15 |
| 7.5 | E-PLUS | TEFC | E320 | $696 | 1800 | 460 | F213T | 9.30 | 88.5% | 0.853 | 9.30 | 7.41 | 6.32 |
| 10 | STANDARD | TEFC | N380 | $705 | 1800 | 460 | 215T | 12.8 | 87.5% | 0.855 | 12.5 | 10.0 | 8.53 |
| 10 | PREMIUM | TEFC | S304 | $1,078 | 1800 | 460 | 215T | 12.5 | 89.5% | 0.852 | 12.3 | 9.78 | 8.34 |
| 10 | VAV | DRIP PF | E381 | $863 | 1800 | 460 | H215T | 12.5 | 89.5% | 0.850 | 12.3 | 9.81 | 8.34 |
| ***10*** | ***E-PLUS III*** | ***TEFC*** | ***E354*** | ***$841*** | ***1800*** | ***460*** | ***215T*** | ***12.4*** | ***91.0%*** | ***0.850*** | ***12.1*** | ***9.64*** | ***8.20*** |
| 10 | E-PLUS | TEFC | E321 | $782 | 1800 | 460 | F215T | 12.5 | 89.5% | 0.838 | 12.5 | 9.95 | 8.34 |
| 15 | STANDARD | TEFC | N470 | $1,060 | 1800 | 460 | 254T | 19.0 | 87.5% | 0.850 | 18.9 | 15.0 | 12.79 |
| 15 | PREMIUM | TEFC | S440 | $1,350 | 1800 | 460 | 254T | 18.0 | 91.0% | 0.870 | 17.7 | 14.1 | 12.30 |
| ***15*** | ***VAV*** | ***DRIP PF*** | ***E480*** | ***$1,162*** | ***1800*** | ***460*** | ***G254T*** | ***18.0*** | ***91.7%*** | ***0.880*** | ***17.4*** | ***13.9*** | ***12.20*** |
| 15 | E-PLUS III | TEFC | E461 | $1,284 | 1800 | 460 | 254T | 18.0 | 91.7% | 0.860 | 17.8 | 14.2 | 12.20 |
| 15 | E-PLUS | TEFC | E420 | $1,194 | 1800 | 460 | S254T | 18.0 | 90.2% | 0.885 | 17.6 | 14.0 | 12.41 |
| 20 | STANDARD | TEFC | N480 | $1,261 | 1800 | 460 | 256T | 24.0 | 89.5% | 0.875 | 23.9 | 19.1 | 16.67 |
| 20 | PREMIUM | TEFC | S441 | $1,682 | 1800 | 460 | 256T | 23.5 | 91.7% | 0.880 | 23.2 | 18.5 | 16.27 |
| 20 | VAV | DRIP PF | E481 | $1,402 | 1800 | 460 | G256T | 24.0 | 91.0% | 0.870 | 23.7 | 18.8 | 16.40 |
| 20 | E-PLUS III | TEFC | E464 | $1,455 | 1800 | 460 | 256T | 23.4 | 93.0% | 0.865 | 23.3 | 18.5 | 16.04 |
| ***20*** | ***E-PLUS*** | ***TEFC*** | ***E421*** | ***$1,353*** | ***1800*** | ***460*** | ***S256T*** | ***24.0*** | ***91.7%*** | ***0.880*** | ***23.2*** | ***18.5*** | ***16.27*** |
| 25 | STANDARD | TEFC | N570 | $1,470 | 1800 | 460 | 284T | 30.0 | 89.5% | 0.870 | 30.1 | 24.0 | 20.84 |
| 25 | PREMIUM | TEFC | S500 | $2,000 | 1800 | 460 | 284T | 28.5 | 93.0% | 0.880 | 28.6 | 22.8 | 20.05 |
| ***25*** | ***VAV*** | ***DRIP PF*** | ***E580*** | ***$1,647*** | ***1800*** | ***460*** | ***E284T*** | ***29.0*** | ***93.0%*** | ***0.885*** | ***28.4*** | ***22.7*** | ***20.05*** |
| 25 | E-PLUS III | TEFC | E550 | $1,905 | 1800 | 460 | 284T | 28.5 | 93.0% | 0.880 | 28.6 | 22.8 | 20.05 |
| 25 | E-PLUS | TEFC | E554 | $1,715 | 1800 | 460 | 284T | 30.0 | 92.4% | 0.850 | 29.8 | 23.7 | 20.18 |
| 30 | STANDARD | TEFC | N580 | $1,737 | 1800 | 460 | 286T | 35.0 | 90.2% | 0.885 | 35.2 | 28.0 | 24.81 |
| 30 | PREMIUM | TEFC | S501 | $2,325 | 1800 | 460 | 286T | 34.0 | 93.0% | 0.890 | 33.9 | 27.0 | 24.06 |
| ***30*** | ***VAV*** | ***DRIP PF*** | ***E581*** | ***$1,934*** | ***1800*** | ***460*** | ***S286T*** | ***34.0*** | ***93.0%*** | ***0.905*** | ***33.4*** | ***26.6*** | ***24.06*** |
| 30 | E-PLUS III | TEFC | E552 | $2,262 | 1800 | 460 | 286T | 33.7 | 93.6% | 0.890 | 33.7 | 26.9 | 23.91 |
| 30 | E-PLUS | TEFC | E555 | $2,039 | 1800 | 460 | 286T | 34.5 | 92.4% | 0.885 | 34.3 | 27.4 | 24.22 |
| 40 | STANDARD | TEFC | N600 | $2,208 | 1800 | 460 | 324T | 47.5 | 91.7% | 0.865 | 47.2 | 37.6 | 32.54 |
| 40 | PREMIUM | TEFC | S600 | $3,105 | 1800 | 460 | 324T | 47.0 | 93.6% | 0.801 | 50.0 | 39.8 | 31.88 |
| 40 | VAV | DRIP PF | E680 | $2,543 | 1800 | 460 | E324T | 46.0 | 93.6% | 0.880 | 45.5 | 36.2 | 31.88 |
| 40 | E-PLUS III | TEFC | E628 | $2,746 | 1800 | 460 | 324T | 44.5 | 94.1% | 0.890 | 44.7 | 35.6 | 31.71 |
| ***40*** | ***E-PLUS*** | ***TEFC*** | ***E620*** | ***$2,471*** | ***1800*** | ***460*** | ***324T*** | ***45.5*** | ***93.0%*** | ***0.895*** | ***45.0*** | ***35.9*** | ***32.09*** |
| 60 | STANDARD | TEFC | N700 | $3,851 | 1800 | 460 | 364T | 70.0 | 91.0% | 0.890 | 69.4 | 55.3 | 49.19 |
| 60 | PREMIUM | TEFC | S676 | $5,472 | 1800 | 460 | 364T | 67.0 | 94.1% | 0.890 | 67.1 | 53.4 | 47.57 |
| ***60*** | ***VAV*** | ***DRIP PF*** | ***E682*** | ***$3,720*** | ***1800*** | ***460*** | ***364T*** | ***67.0*** | ***94.1%*** | ***0.905*** | ***66.0*** | ***52.6*** | ***47.57*** |
| 60 | E-PLUS III | TEFC | E720 | $5,027 | 1800 | 460 | 364T | 67.0 | 94.1% | 0.890 | 67.1 | 53.4 | 47.57 |
| 60 | E-PLUS | TEFC | N/A | N/A | 1800 | 460 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

(1) INFORMATION BASED ON MAGNETEK COMMERCIAL/INDUSTRIAL MOTOR CATALOG, BULETIN 943, JANUARY 31, 1992.

(2) PRICES ARE AS OF JANUARY 31, 1992, VERIFY CURRENT PRICING BEFORE USING PRICES IN ESTIMATES.

(3) CALCULATION IS COMPUTED FOR CURRENT AS FOLLOWS: FLA = (HP x 746) / (SQAREROOT (3) x VOLTAGE x EFFICIENCY x POWER FACTOR).

(4) CALCULATION IS COMPUTED FOR KILOVOLT-AMPERES AS FOLLOWS: KVA = RATED VOLTAGE x CALCULATED CURRENTx (SQAREROOT (3) / 1000.

(5) CALCULATION IS COMPUTED FOR KILOWATTS AS FOLLOWS: KW = CALCULATED KVA X POWER FACTOR.

| ITEM | ECO-E<br>LSTC BUILDING, ECO-D LIGHTING & HVAC SYSTEMS<br>MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 376,570 | |
| Chiller CH-1 | 84.7 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 412,735 | |
| Chiller CH-3 | | 22.5 | 23.5 | 27.4 | 30.4 | 32.0 | 33.4 | 33.2 | 31.6 | 29.4 | 23.3 | 22.5 | 36,776 | |
| Twr. Fan CT-1A | 8.5 | 8.7 | 8.9 | 9.9 | 11.8 | 12.5 | 12.5 | 12.5 | 12.5 | 10.6 | 8.8 | 8.7 | 46,726 | |
| Twr. Fan CT-1B | | | | 1.8 | 6.3 | 10.8 | 10.8 | 10.8 | 10.8 | 3.7 | | | 7,704 | |
| HW pump P-5 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 16.6 | 66,649 | |
| CHW Pump P-7 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 39.3 | 344,268 | |
| CND Pump 10A | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 27.5 | 240,900 | |
| CND Pump 10B | | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 18.3 | 32,080 | |
| Fan EF-1 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 4,423 | |
| Fan EF-2 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 10,031 | |
| Fan AH1 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 22,280 | |
| Fan AH2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 39,733 | |
| Fan AH3 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 15,207 | |
| Fan AH5 | 5.0 | 10.1 | 10.1 | 14.1 | 17.2 | 17.2 | 17.2 | 17.2 | 17.2 | 14.1 | 10.1 | 10.1 | 25,319 | |
| Fan AH6 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 13.9 | 38,539 | |
| Fan AH7 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 25,459 | |
| Fan AHS1 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 5,593 | |
| Fan AHS4 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 18,054 | |
| Fan AH-8 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 28,908 | |
| Fan AH-9 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| Fan AH-10 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 15,768 | |
| Fan AH-11A | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 32,412 | |
| Fan AH-11B | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 41,172 | |
| Fan AH-12 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 28,908 | |
| Fan AH-14 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 49,056 | |
| | | | | | | | | | | | | | | |
| Totals | 378.7 | 428.2 | 429.4 | 440.1 | 452.6 | 459.4 | 460.8 | 460.6 | 459.0 | 444.7 | 429.1 | 428.2 | 2,014,326 | |

Total Energy 6,875 MMBTU/yr (electric)

Total Energy MMBTU/yr (diesel)

| ITEM | ECO-E<br>LSTC BUILDING, PROPOSED LIGHTING & HVAC SYSTEMS<br>MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 376,570 | |
| Chiller CH-1 | 84.7 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 412,735 | |
| Chiller CH-3 | | 22.5 | 23.5 | 27.4 | 30.4 | 32.0 | 33.4 | 33.2 | 31.6 | 29.4 | 23.3 | 22.5 | 36,776 | |
| Twr. Fan CT-1A | 8.1 | 8.4 | 8.5 | 9.5 | 11.3 | 12.0 | 12.0 | 12.0 | 12.0 | 10.2 | 8.5 | 8.4 | 44,857 | |
| Twr. Fan CT-1B | | | | 1.7 | 6.1 | 10.4 | 10.4 | 10.4 | 10.4 | 3.6 | | | 7,419 | |
| HW pump P-5 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 63,035 | |
| CHW Pump P-7 | 38.9 | 38.9 | 38.9 | 38.9 | 38.9 | 38.9 | 38.9 | 38.9 | 38.9 | 38.9 | 38.9 | 38.9 | 340,764 | |
| CND Pump 10A | 24.8 | 24.8 | 24.8 | 24.8 | 24.8 | 24.8 | 24.8 | 24.8 | 24.8 | 24.8 | 24.8 | 24.8 | 217,248 | |
| CND Pump 10B | | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 31,028 | |
| Fan EF-1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 4,055 | |
| Fan EF-2 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 8,916 | |
| Fan AH1 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 20,567 | |
| Fan AH2 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 37,785 | |
| Fan AH3 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 14,037 | |
| Fan AH5 | 4.8 | 9.7 | 9.7 | 13.5 | 16.5 | 16.5 | 16.5 | 16.5 | 16.5 | 13.5 | 9.7 | 9.7 | 24,294 | |
| Fan AH6 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 36,876 | |
| Fan AH7 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 25,062 | |
| Fan AHS1 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 5,629 | |
| Fan AHS4 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 17,736 | |
| Fan AH-8 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 27,156 | |
| Fan AH-9 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 43,800 | |
| Fan AH-10 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 14,892 | |
| Fan AH-11A | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 30,660 | |
| Fan AH-11B | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 38,544 | |
| Fan AH-12 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 27,156 | |
| Fan AH-14 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 43,800 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 368.8 | 417.6 | 418.7 | 429.1 | 441.3 | 447.9 | 449.3 | 449.1 | 447.5 | 433.7 | 418.5 | 417.6 | 1,951,397 | |

Energy Savings 215 MMBTU/yr (electric)

Energy Savings MMBTU/yr (diesel)

| ITEM | ECO-E<br>TC-1 & TC-2 BUILDINGS, ECO-C LIGHTING & HVAC SYSTEMS<br>MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 356,670 | |
| Chiller CH-51 | 37.7 | 38.7 | 49.6 | 56.2 | 63.9 | 71.5 | 76.0 | 74.3 | 66.1 | 56.2 | 38.4 | 38.0 | 400,851 | |
| Chiller CH-52 | | | | | | | | | | | | | | |
| Twr. Fan CT-51A | 4.5 | 4.7 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 5.0 | 4.6 | 42,143 | |
| Twr. Fan CT-51B | | | | | | | | | | | | | | |
| CHW Pump P-51 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 27.3 | 239,148 | |
| CHW Pump P-52 | | | | | | | | | | | | | | |
| CND Pump P-60 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 115,632 | |
| CND Pump P-61 | | | | | | | | | | | | | | |
| CND Pump P-65 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 22.3 | 195,348 | |
| CND Pump P-66 | | | | | | | | | | | | | | |
| Boiler B-51 | | | | | | | | | | | | | | 13,913 |
| Boiler B-52 | | | | | | | | | | | | | | |
| HW pump P-70 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 23,652 | |
| HW pump P-71 | | | | | | | | | | | | | | |
| HW pump P-63 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | 56,064 | |
| HW pump P-64 | | | | | | | | | | | | | | |
| Fan AH-1 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 76,212 | |
| Fan AH-2 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 18,396 | |
| Fan AH-3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 90,228 | |
| Fan AH-4 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 42,924 | |
| Fan AH-5 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 35,916 | |
| Fan AH-51 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 42,924 | |
| Fan AH-52 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 14,892 | |
| Fan AH-53 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 75,336 | |
| Fan AH-54 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 38,544 | |
| Fan AH-55 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 35,916 | |
| | | | | | | | | | | | | | | |
| Totals | 211.3 | 212.5 | 224.0 | 230.6 | 238.3 | 245.9 | 250.4 | 248.7 | 240.5 | 230.6 | 212.5 | 211.7 | 1,900,796 | 13,913 |

Total Energy 6,487 MMBTU/yr (electric)

Total Energy 1,391 MMBTU/yr (diesel)

| ITEM | ECO-E<br>TC-1 & TC-2 BUILDINGS, PROPOSED LIGHTING & HVAC SYSTEMS<br>MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 356,670 | |
| Chiller CH-51 | 37.7 | 38.7 | 49.6 | 56.2 | 63.9 | 71.5 | 76.0 | 74.3 | 66.1 | 56.2 | 38.4 | 38.0 | 400,851 | |
| Chiller CH-52 | | | | | | | | | | | | | | |
| Twr. Fan CT-51A | 4.0 | 4.2 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.4 | 4.1 | 37,372 | |
| Twr. Fan CT-51B | | | | | | | | | | | | | | |
| CHW Pump P-51 | 26.8 | 26.8 | 26.8 | 26.8 | 26.8 | 26.8 | 26.8 | 26.8 | 26.8 | 26.8 | 26.8 | 26.8 | 234,768 | |
| CHW Pump P-52 | | | | | | | | | | | | | | |
| CND Pump P-60 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 113,880 | |
| CND Pump P-61 | | | | | | | | | | | | | | |
| CND Pump P-65 | 21.6 | 21.6 | 21.6 | 21.6 | 21.6 | 21.6 | 21.6 | 21.6 | 21.6 | 21.6 | 21.6 | 21.6 | 189,216 | |
| CND Pump P-66 | | | | | | | | | | | | | | |
| Boiler B-51 | | | | | | | | | | | | | | 13,913 |
| Boiler B-52 | | | | | | | | | | | | | | |
| HW pump P-70 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 20,148 | |
| HW pump P-71 | | | | | | | | | | | | | | |
| HW pump P-63 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 55,188 | |
| HW pump P-64 | | | | | | | | | | | | | | |
| Fan AH-1 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 68,328 | |
| Fan AH-2 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 17,520 | |
| Fan AH-3 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 86,724 | |
| Fan AH-4 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 41,172 | |
| Fan AH-5 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 36,792 | |
| Fan AH-51 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 42,924 | |
| Fan AH-52 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 12,264 | |
| Fan AH-53 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 74,460 | |
| Fan AH-54 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 38,544 | |
| Fan AH-55 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 32,412 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 206.6 | 207.8 | 219.2 | 225.8 | 233.5 | 241.1 | 245.6 | 243.9 | 235.7 | 225.8 | 207.7 | 207.0 | 1,859,233 | 13,913 |

Energy Savings 142 MMBTU/yr (electric)

Energy Savings MMBTU/yr (diesel)

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - LSTC, TEST CELL 1 & 2

**ECO NO.** E

**PROJECT NO:** 03-0185.05 **DATE:** 8/12/96

**BY :** HOWARD, D. **CHECKED BY:** HOWARD, D.

**PROJECT DESCRIPTION:** Install Energy Efficient Motors

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Install 1 HP energy efficient motor | | ea | 1.8 | 30.00 | | 182.00 | | |
| Install 1.5 HP energy efficient motor | 1 | ea | 1.8 | 30.00 | 54 | 210.00 | 210 | 264 |
| Install 2 HP energy efficient motor | 2 | ea | 1.8 | 30.00 | 108 | 239.00 | 478 | 586 |
| Install 3 HP energy efficient motor | 4 | ea | 1.8 | 30.00 | 216 | 250.00 | 1,000 | 1,216 |
| Install 5 HP energy efficient motor | 7 | ea | 1.8 | 30.00 | 378 | 300.00 | 2,100 | 2,478 |
| Install 7.5 HP energy efficient motor | 11 | ea | 1.9 | 30.00 | 627 | 370.00 | 4,070 | 4,697 |
| Install 10 HP energy efficient motor | 4 | ea | 2.0 | 30.00 | 240 | 460.00 | 1,840 | 2,080 |
| Install 15 HP energy efficient motor | 7 | ea | 2.5 | 30.00 | 525 | 695.00 | 4,865 | 5,390 |
| Install 25 HP energy efficient motor | 3 | ea | 3.2 | 30.00 | 288 | 1,075.00 | 3,225 | 3,513 |
| Install 30 HP energy efficient motor | 4 | ea | 3.3 | 30.00 | 396 | 1,250.00 | 5,000 | 5,396 |
| Install 40 HP energy efficient motor | 3 | ea | 4.0 | 30.00 | 360 | 1,675.00 | 5,025 | 5,385 |
| Install 60 HP energy efficient motor | 1 | ea | 5.7 | 30.00 | 171 | 2,500.00 | 2,500 | 2,671 |
| | | | | SUBTOTAL | 3,363 | | 30,313 | 33,676 |
| | | | | O & P @ 20% | 673 | | 6,063 | 6,736 |
| | | | | SUBTOTAL | 4,036 | | 36,376 | 40,412 |
| | | | | DESIGN @ 6% | | | | 2,425 |
| | | | | SUBTOTAL | | | | 42,837 |
| | | | | SIOH @ 5.5% | | | | 2,356 |
| | | | | NMGRT @ 6% | | | | 2,570 |
| | | | | AREA ADJUST. @ 10% | | | | 4,284 |
| | | | | TOTAL | | | | $52,046 |


**HUITT-ZOLLARS, INC.**

**ENGINEERS / ARCHITECTS**

512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: HELSTF - LSTC

ECO NO. E

PROJECT NO: 03-0185.05

DATE: 4/11/96

BY : HOWARD, D.

CHECKED BY: HOWARD, D.

PROJECT DESCRIPTION: Install Energy Efficient Motors

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Install 1 HP energy efficient motor | | ea | 1.8 | 30.00 | | 182.00 | | |
| Install 1.5 HP energy efficient motor | 1 | ea | 1.8 | 30.00 | 54 | 210.00 | 210 | 264 |
| Install 2 HP energy efficient motor | 1 | ea | 1.8 | 30.00 | 54 | 239.00 | 239 | 293 |
| Install 3 HP energy efficient motor | 1 | ea | 1.8 | 30.00 | 54 | 250.00 | 250 | 304 |
| Install 5 HP energy efficient motor | 4 | ea | 1.8 | 30.00 | 216 | 300.00 | 1,200 | 1,416 |
| Install 7.5 HP energy efficient motor | 3 | ea | 1.9 | 30.00 | 171 | 370.00 | 1,110 | 1,281 |
| Install 10 HP energy efficient motor | 2 | ea | 2.0 | 30.00 | 120 | 460.00 | 920 | 1,040 |
| Install 15 HP energy efficient motor | 4 | ea | 2.5 | 30.00 | 300 | 695.00 | 2,780 | 3,080 |
| Install 25 HP energy efficient motor | 3 | ea | 3.2 | 30.00 | 288 | 1,075.00 | 3,225 | 3,513 |
| Install 30 HP energy efficient motor | 2 | ea | 3.3 | 30.00 | 198 | 1,250.00 | 2,500 | 2,698 |
| Install 40 HP energy efficient motor | 1 | ea | 4.0 | 30.00 | 120 | 1,675.00 | 1,675 | 1,795 |
| Install 60 HP energy efficient motor | 1 | ea | 5.7 | 30.00 | 171 | 2,500.00 | 2,500 | 2,671 |
| | | | | SUBTOTAL | 1,746 | | 16,609 | 18,355 |
| | | | | O & P @ 20% | 349 | | 3,322 | 3,671 |
| | | | | SUBTOTAL | 2,095 | | 19,931 | 22,026 |
| | | | | DESIGN @ 6% | | | | 1,322 |
| | | | | SUBTOTAL | | | | 23,348 |
| | | | | SIOH @ 5.5% | | | | 1,284 |
| | | | | NMGRT @ 6% | | | | 1,401 |
| | | | | AREA ADJUST. @ 10% | | | | 2,335 |
| | | | | TOTAL | | | | $28,368 |

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# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: HELSTF - TEST CELL 1 & 2

ECO NO. E

PROJECT NO: 03-0185.05 | DATE: 4/11/96

BY : HOWARD, D. | CHECKED BY: CARTER, J.

PROJECT DESCRIPTION: Install Energy Efficient Motors

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| Install 1 HP energy efficient motor | | ea | 1.8 | 30.00 | | 182.00 | | |
| Install 1.5 HP energy efficient motor | | ea | 1.8 | 30.00 | | 210.00 | | |
| Install 2 HP energy efficient motor | 1 | ea | 1.8 | 30.00 | 54 | 239.00 | 239 | 293 |
| Install 3 HP energy efficient motor | 3 | ea | 1.8 | 30.00 | 162 | 250.00 | 750 | 912 |
| Install 5 HP energy efficient motor | 3 | ea | 1.8 | 30.00 | 162 | 300.00 | 900 | 1,062 |
| Install 7.5 HP energy efficient motor | 8 | ea | 1.9 | 30.00 | 456 | 370.00 | 2,960 | 3,416 |
| Install 10 HP energy efficient motor | 2 | ea | 2.0 | 30.00 | 120 | 460.00 | 920 | 1,040 |
| Install 15 HP energy efficient motor | 3 | ea | 2.5 | 30.00 | 225 | 695.00 | 2,085 | 2,310 |
| Install 25 HP energy efficient motor | | ea | 3.2 | 30.00 | | 1,075.00 | | |
| Install 30 HP energy efficient motor | 2 | ea | 3.3 | 30.00 | 198 | 1,250.00 | 2,500 | 2,698 |
| Install 40 HP energy efficient motor | 2 | ea | 4.0 | 30.00 | 240 | 1,675.00 | 3,350 | 3,590 |
| Install 60 HP energy efficient motor | | ea | 5.7 | 30.00 | | 2,500.00 | | |
| | | | | SUBTOTAL | 1,617 | | 13,704 | 15,321 |
| | | | | O & P @ 20% | 323 | | 2,741 | 3,064 |
| | | | | SUBTOTAL | 1,940 | | 16,445 | 18,385 |
| | | | | DESIGN @ 6% | | | | 1,103 |
| | | | | SUBTOTAL | | | | 19,488 |
| | | | | SIOH @ 5.5% | | | | 1,072 |
| | | | | NMGRT @ 6% | | | | 1,169 |
| | | | | AREA ADJUST. @ 10% | | | | 1,949 |
| | | | | TOTAL | | | | $23,678 |

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Life Cycle Cost Analysis — Study: HELSTF.LC
Energy Conservation Investment Program (ECIP) — LCCID FY96
Installation & Location: WSMR
Region data: NEW — Census Region: 4
Project NO. & Title: 03-0185.05 EEAP ENERGY STUDY - HELSTF FACILITY
Fiscal Year: 1997 Discrete Portion: ECO-E
Analysis Date: 08/16/96 Economic Life: 20 years
Prepared by: MICHAEL W. ELLIOTT, P.E., CEM

## ECIP Summary Report

1. Investment
   - A. Construction Cost — $47,625
   - B. SIOH — $2,356
   - C. Design Cost — $2,425
   - D. Total Cost (1A+1B+1C) — $52,406
   - E. Salvage Value of Existing Equip. — $0
   - F. Public Utility Company Rebate — $0
   - G. Total Investment (1D-1E-1F) — $52,406

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1995

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $25. | /Mbtus | 357 | Mbtus | $8,911 | 14.47 | $128,938 |
| Elec. Deman | | | | | $0 | 13.47 | $0 |
| Distillate | $. | /Mbtus | 0 | Mbtus | $0 | 17.01 | $0 |
| Residual Oi | $. | /Mbtus | 0 | Mbtus | $0 | 17.23 | $0 |
| Natural Gas | $. | /Mbtus | 0 | Mbtus | $0 | 17.32 | $0 |
| Coal | $. | /Mbtus | 0 | Mbtus | $0 | 14.04 | $0 |
| LPG | $6.5 | /Mbtus | 0 | Mbtus | $0 | 15.64 | $0 |
| Solar | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Geothermal | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Biomass | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Refuse | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Wind | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Other | $7. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| TOTAL | | | 357 | Mbtus | $8,911 | | $128,938 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

4. First Year Dollar Savings — $8,911
5. Simple Payback Period (Years) — 5.88
6. Total Net Discounted Savings — $128,938
7. Savings to Investment Ratio — 2.46
   If < 1, Project does not qualify
8. Adjusted Internal Rate of Return — 8.89%

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | F |
| DATE: | 5/6/96 |
| ECO TITLE: | Replace Existing Chillers With More Efficient Chillers |
| INSTALLATION: | HELSTF, LSTC Building |
| LOCATION: | White Sands Missile Range, New Mexico |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 2,324 | MMBTU/yr |
| Propane Energy Savings | -906 | MMBTU/yr |
| Total Energy Savings | 1,418 | MMBTU/yr |
| Total Cost Savings | 52,154 | $/yr |
| Total Investment | 415,174 | $ |
| Simple Payback | 7.8 | yrs |
| SIR | 1.86 | |

B. ECO Description:

Remove the three (3) existing, R-11, centrifugal chillers (CH-1, 2, and 3) in the basement of the LSTC building. Replace chiller CH-1 with a new 59 ton, R-22, reciprocating chiller in the same location. Replace chillers CH-2 and CH-3 with new 180 ton, R-123, screw chillers in the same location. One of the 180 ton chillers will be used as a back up chiller. Pipe the new chillers to the existing chilled water (CHW) distribution system in a parallel configuration. Remove the existing 60 HP CHW pump P-7, serving the two active chillers in series. Install a new 5 HP CHW pump, P-7A to serve the new 59 ton chiller and two new 15 HP CHW pumps, P-7B and 7C to serve the new 180 ton chillers. Connect the new pumps to the existing CHW return header. Remove the two (2) existing 30 HP condenser water (CND) pumps, P-10A, 10B, serving the existing chillers. Install a new 10 HP CND pump, P-10A to serve the new 59 ton chiller and two new 20 HP CND pumps, P-10B and 10C to serve the new 180 ton chillers. Connect the new pumps to the existing condenser water return header. Reuse the existing cooling tower. Remove the existing, 5023 MBH, oil fired, steam boiler which is also in the basement abate the exterior insulation containing asbestos. Replace it with a new 1000 MBH, propane fired, modular, HW boiler in the same location. Remove the existing flue and replace with a new stainless steel exhaust flue and in-line exhaust fan to assist stack exhaust. Remove the diesel fuel piping and diesel fuel tanks for the boiler. Provide one, 400 galbn, aboveground tank at grade level, and route approximately 150 feet of 1-1/2" steel pipe from tanks to boiler located in the basement. Remove the existing 25 HP heating water pump P-5, serving the heat reclaim systems on the existing chillers. Replace it with a new 3/4 HP heating water pump to serve the new heating water boiler and terminal reheat coils. Remove the thirty-nine (39) existing, duct mounted, terminal reheat coils throughout the building. Replace them with the same number of new coils, selected to use 180°F heating water with a 40°F drop through the coil. The existing piping and controls will remain or connect the new equipment to the building energy management system if implemented. To meet the current ASHRAE Standard 15, a refrigerant detection and ventilation system shall be installed. Provide a new chemical treatment system and a propane gas detector and alarm for the proposed boiler capable of interfacing with the proposed EMS from a previous ECO. Reuse the existing electrical distribution systems wherever possible. This ECO will require engineering design drawings and specifications, as well as the system modifications mentioned above.

C. Discussion:

demand would be 175 tons. To meet this load with the existing chillers would mean operating them at an inefficient, low load condition. Since both machines are the same size, optimization of chiller operation with variable cooling loads is currently not possible. And the current series piping arrangement of the two machines requires the 60 HP CHW pump P-7 to operate continuously, regardless of cooling loads. Also the existing machines use the R-11 refrigerant which is being phased out by current federal CFC regulations. Finally, the existing machines are more than 13 years old and in generally poor condition.

Replacing these units with new chillers of 59 tons (0.85 KW/ton at full load) and 180 tons (0.59 KW/ton at full load) will allow the building EMS to select the most efficient machine to operate at any given part load condition. Also, parallel piping of the new machines will allow the reduction of CHW pumping energy at part load conditions. The larger more efficient screw chiller will modulate between a full load of 175 tons (new calculated full load) to a minimum 30%, (180 tons x 0.3) 54-ton load. According to one manufacturer, this chiller can safely operate down to 18 tons. However, the power draw will be approximately 1.8 KW/ton at this low load condition. Therefore, once the cooling load falls below 50 tons, the large chiller will de-energize and the smaller 50-ton chiller will cycle. This chiller will have a four-stage capacity control and will handle all cooling loads below 50 tons. Once the cooling load becomes greater than 60 tons, the small chiller will shut down and the larger chiller will cycle. In cycling on the larger chiller at a 60-ton demand load, this will prevent the frequent start-up and shut down of chillers between 50 - 60 ton cooling range. Also, selection of a larger than 175 ton chiller will provide an extra safety margin and prevent simultaneous operation of the 50 ton and 180 ton chillers. Due to the critical operation of the facility, a third 180-ton screw chiller has been selected as a back up chiller. The two 180 ton chillers can be cycled to reduce the operational hours of each of the chillers and increase the expected life of each machine.

A screw chiller was selected over an R-123 centrifugal of the same size because of its first cost. In general, a screw machine is more efficient yet also more costly. However, in this size range, both machines are approximately equal in the full range of efficiency, but the screw machine is approximately $15,000 less expensive. Moreover, a centrifugal chiller in the 180-ton capacity range, using refrigerant R-134a is not available (manufactured), hence this option was not evaluated. The possibility of a direct gas fired absorption chiller was not evaluated due to the unavailability of natural gas at the facility. Lastly, preliminary evaluations of a steam operated absorption chiller showed it to be highly uneconomical for this building.

With the reduction in the cooling load at the same temperature differential, the required chilled water flow and condenser water flow will also reduce. Moreover, in utilizing the existing piping and AHU coils, as the flow through the piping system decreases the head on the pump will decrease also. Therefore, new CHW and CND pumps will be selected. Refer to the equipment list included in this ECO on page B-109 for new pump sizes.

With higher AHU supply air temperatures, the quantity of reheating and heating water flow GPM will also be reduced. Due to smaller size chillers, a heat recovery package could make them inefficient. Moreover, facility maintenance personnel have recommended separate cooling and heating systems. Therefore, a new, fully modulating, packaged, HW boiler will be installed to furnish the supplementary heating needs. Since natural gas is not available at the facility, the base has requested propane be used. The facility appeared to have had problems in the past of exhausting the flue gases from the building. Therefore, a 250 CFM, in-line, exhaust fan needs to be installed for exhausting the flue stack. This new HW boiler was sized using the heating load profile from the Trace 600 computer model[1].

D. Savings Calculations:

1. Energy Savings:

The monthly peak demand and energy consumption of the LSTC's HVAC systems before and after installation of the new chillers and boiler were calculated using the Trace 600 computer program[1]. In order to account for previously derived savings, the HVAC and lighting systems from all previous ECOs were used as initial conditions for this ECO. The computer models provided realistic energy usage profiles for both conditions. Field data obtained from the buildings were used to create these computer building models[2].

Once the computer simulations were completed, the total annual demand costs and energy consumptions of the existing and proposed HVAC systems were compared to determine the annual savings from this ECO. These savings calculations are shown on pages B-110 to B-111.

2. Maintenance Cost Savings:

By installing new chillers in place of the existing ones, the installation will save the cost of retrofitting the existing machines for the HCFC-123 refrigerant. This retrofit would be required in the near future due to the current restrictions on the R-11 refrigerant and future refrigerant price escalation. A simple retrofit of these chillers can involve replacing valves and gaskets and reprogramming controls. However, in a simple retrofit, the chiller can lose as much as 15-20 % in capacity and also increase the KW/ton of the machine. Therefore, to maintain the capacity within 5%; the gears need to also be replaced which can be quite expensive. The estimated cost of doing the latter retrofit is approximately $35,000 per chiller. This amounts to a total, one time maintenance cost savings of $70,000. This value was used in the life cycle cost analysis as a non-recurring savings in the first year of the ECO life.

E. Cost Estimate:

The total implementation costs for this ECO were estimated on page B-112. Manufacturer's data on the new chillers, pumps and boiler is included in Appendix E (Volume II, Tab 5). This data was used to produce the estimated ECO implementation cost.

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cycle Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. An item for the cost of disposing R-11 refrigerant was input into the program based on $2.00 per pound and 2 pounds per ton of chillers. This cost was added to a basic cost of $1,600 associated with removing the refrigerant from the machines. The summary sheet for the life cycle cost analysis is shown on page B-115. The "Other" fuel type shown in Section # 2 is for diesel fuel consumption. The results of the analysis are listed in the summary on page B-106.

REFERENCES

1. See Appendix G (Volume II, Tab 7) for Trace 600 input and output data for this ECO.

2. See Appendix F (Volume II, Tab 6) for building field data used to create computer models.

PROPOSED HVAC EQUIPMENT LIST FOR ECO-F: HELSTF Facility, LSTC Building
M,ay 6, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | FULL LOAD | OPERATING TIMES HRS | OPERATING TIMES DAYS | OPERATING TIMES WKS | ANNUAL USE KWH | ANNUAL USE GAL |
|---|---|---|---|---|---|---|---|---|---|
| CH-1<br>Water Chiller | 1 | York YCWZ33AB0<br>59 ton, R-22 | chilled water | 50.0 KW | by computer model | | | 107,546 | |
| CH-3<br>Water Chiller | 1 | York YT Screw<br>180 ton, R-123 | chilled water | 106.0 KW | by computer model | | | 177,919 | |
| CH-2<br>Water Chiller | 1 | York YT Screw<br>180 ton, R-123 | back-up chiller | 106.0 KW | back-up only | | | 0 | |
| B-1<br>HW Boiler<br>Propane Fired | 1 | Bryan HECL-90W<br>665 MBH out, 180F HW | heating water | 900 MBH | by computer model | | | | 9,954 |
| P-5<br>Pump<br>Heating Water | 1 | B&G Series 60<br>36 gpm, 17 ft head<br>3/4 HP | heating water<br>B-1 | 0.5 KW | by computer model | | | 4,468 | |
| P-7A<br>Pump<br>Chilled Water | 1 | B&G Series 80<br>126 gpm, 74 ft head<br>5 HP | chilled water<br>CH-1 | 3.2 KW | by computer model | | | 18,359 | |
| P-7B<br>Pump<br>Chilled Water | 1 | B&G Series 1510<br>442 gpm, 74 ft head<br>15 HP | chilled water<br>CH-2 | 9.4 KW | by computer model | | | 29,237 | |
| P-7C<br>Pump<br>Chilled Water | 1 | B&G Series 1510<br>442 gpm, 74 ft head<br>15 HP | chilled water<br>CH-3 | 9.4 KW | back-up only | | | 0 | |
| P-10A<br>Pump<br>Condenser Water | 1 | B&G Series 1510<br>200 gpm, 90 ft head<br>10 HP | condenser water<br>CH-1 | 5.6 KW | by computer model | | | 31,717 | |
| P-10B<br>Pump<br>Condenser Water | 1 | B&G Series 1510<br>540 gpm, 90 ft head<br>20 HP | condenser water<br>CH-2 | 12.2 KW | by computer model | | | 38,149 | |
| P-10C<br>Pump<br>Condenser Water | 1 | B&G Series 1510<br>540 gpm, 90 ft head<br>20 HP | condenser water<br>CH-3 | 12.2 KW | back-up only | | | 0 | |
| Cooling Tower Fan<br>CT-1A | 1 | BAC model CFT-2420C | condenser water | 12.5 KW | by computer model | | | 40,866 | |
| Cooling Tower Fan<br>CT-1B | 1 | BAC model CFT-2420C | condenser water | 10.8 KW | by computer model | | | 24,557 | |

| ITEM | ECO-F<br>LSTC BUILDING, ECO-E LIGHTING & HVAC SYSTEMS<br>MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL PROPANE USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 376,570 | |
| Chiller CH-1 | 84.7 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 88.1 | 412,735 | |
| Chiller CH-3 | | 22.5 | 23.5 | 27.4 | 30.4 | 32.0 | 33.4 | 33.2 | 31.6 | 29.4 | 23.3 | 22.5 | 36,776 | |
| Twr. Fan CT-1A | 8.1 | 8.4 | 8.5 | 9.5 | 11.3 | 12.0 | 12.0 | 12.0 | 12.0 | 10.2 | 8.5 | 8.4 | 44,857 | |
| Twr. Fan CT-1B | | | | 1.7 | 6.1 | 10.4 | 10.4 | 10.4 | 10.4 | 3.6 | | | 7,419 | |
| HW pump P-5 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 15.7 | 63,035 | |
| CHW Pump P-7 | 38.9 | 38.9 | 38.9 | 38.9 | 38.9 | 38.9 | 38.9 | 38.9 | 38.9 | 38.9 | 38.9 | 38.9 | 340,764 | |
| CND Pump 10A | 24.8 | 24.8 | 24.8 | 24.8 | 24.8 | 24.8 | 24.8 | 24.8 | 24.8 | 24.8 | 24.8 | 24.8 | 217,248 | |
| CND Pump 10B | | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 17.7 | 31,028 | |
| Fan EF-1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 4,055 | |
| Fan EF-2 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 8,916 | |
| Fan AH1 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 20,567 | |
| Fan AH2 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 37,785 | |
| Fan AH3 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 14,037 | |
| Fan AH5 | 4.8 | 9.7 | 9.7 | 13.5 | 16.5 | 16.5 | 16.5 | 16.5 | 16.5 | 13.5 | 9.7 | 9.7 | 24,294 | |
| Fan AH6 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 36,876 | |
| Fan AH7 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 25,062 | |
| Fan AHS1 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 5,629 | |
| Fan AHS4 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 17,736 | |
| Fan AH-8 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 27,156 | |
| Fan AH-9 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 43,800 | |
| Fan AH-10 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 14,892 | |
| Fan AH-11A | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 30,660 | |
| Fan AH-11B | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 38,544 | |
| Fan AH-12 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 27,156 | |
| Fan AH-14 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 43,800 | |
| | | | | | | | | | | | | | | |
| Totals | 368.8 | 417.6 | 418.7 | 429.1 | 441.3 | 447.9 | 449.3 | 449.1 | 447.5 | 433.7 | 418.5 | 417.6 | 1,951,397 | |

Total Energy 6,660 MMBTU/yr (electric)

Total Energy MMBTU/yr (propane)

| ITEM | ECO-F LSTC BUILDING, PROPOSED LIGHTING & HVAC SYSTEMS MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL PROPANE USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 94.8 | 376,570 | |
| New Chiller CH-1 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 | 107,546 | |
| NewChiller CH-3 | 53.2 | 56.1 | 61.9 | 65.4 | 68.9 | 73.5 | 76.1 | 75.8 | 72.8 | 67.2 | 61.7 | 57.6 | 177,919 | |
| New HW Boiler B-1 | | | | | | | | | | | | | | 9,058 |
| Twr. Fan CT-1A | 11.5 | 11.6 | 11.5 | 11.6 | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 11.5 | 11.5 | 11.6 | 40,866 | |
| Twr. Fan CT-1B | 6.4 | 6.9 | 7.3 | 8.8 | 10.4 | 10.4 | 10.4 | 10.4 | 10.4 | 9.4 | 7.6 | 6.9 | 24,557 | |
| New HW pump P-5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 4,468 | |
| New CHW Pump P-7A | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 18,359 | |
| New CHW Pump P-7B | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 9.4 | 29,237 | |
| New CND Pump 10A | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 31,717 | |
| New CND Pump 10B | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 12.2 | 38,149 | |
| Fan EF-1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 4,055 | |
| Fan EF-2 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 8,916 | |
| Fan AH1 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 20,567 | |
| Fan AH2 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 | 37,785 | |
| Fan AH3 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 14,037 | |
| Fan AH5 | 4.8 | 9.7 | 9.7 | 13.5 | 16.5 | 16.5 | 16.5 | 16.5 | 16.5 | 13.5 | 9.7 | 9.7 | 24,294 | |
| Fan AH6 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 13.3 | 36,876 | |
| Fan AH7 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 7.2 | 25,062 | |
| Fan AHS1 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 5,629 | |
| Fan AHS4 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 17,736 | |
| Fan AH-8 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 27,156 | |
| Fan AH-9 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 43,800 | |
| Fan AH-10 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 14,892 | |
| Fan AH-11A | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 30,660 | |
| Fan AH-11B | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 38,544 | |
| Fan AH-12 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 27,156 | |
| Fan AH-14 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 43,800 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 348.6 | 357.0 | 363.1 | 372.0 | 380.5 | 385.1 | 387.7 | 387.4 | 384.4 | 374.3 | 363.2 | 358.5 | 1,270,353 | 9,058 |

Energy Savings 2,324 MMBTU/yr (electric)

Energy Savings -906 MMBTU/yr (propane)

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - LSTC

**ECO NO.** F

**PROJECT NO:** 03-0185.05 **DATE:** 7/24/96

**BY :** KOTHMAN, K. **CHECKED BY:** HOWARD, D.

**PROJECT DESCRIPTION:** Chiller Retrofit

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE THE FOLLOWING : | | | | | | | | |
| CHILLER CH-1 YORK 177 TON R-11 | 1 | EA | 138 | 22.91 | $3,162 | | | $3,162 |
| CHILLER CH-2 YORK 265 TON R-11 | 1 | EA | 212 | 22.91 | $4,857 | | | $4,857 |
| CHILLER CH -3 YORK 156 TON R-11 | 1 | EA | 138 | 22.91 | $3,162 | | | $3,162 |
| HW BOILER B-1 DIESEL FIRED 5023 MBH | 1 | EA | 32 | 22.91 | $733 | | | $733 |
| HEATING WTR PUMP P-5 25 HP | 1 | EA | 6 | 22.91 | $137 | | | $137 |
| CHILLED WTR PUMP P-7 60 HP | 1 | EA | 14 | 22.91 | $321 | | | $321 |
| CHILLED WTR PUMP P-8 60 HP | 1 | EA | 14 | 22.91 | $321 | | | $321 |
| COND WTR PUMP P-10A 30 HP | 1 | EA | 7 | 22.91 | $160 | | | $160 |
| COND WTR PUMP P-10B 30 HP | 1 | EA | 7 | 22.91 | $160 | | | $160 |
| DUCT MNT REHEAT COIL LARGE 24X42 AVG DEMINSION | 17 | EA | 2.0 | 22.91 | $779 | | | $779 |
| DUCT MNT REHEAT COIL SMALL12X16 AVG DEMINSION | 22 | EA | 0.8 | 22.91 | $403 | | | $403 |
| ASBESTOS ABATEMENT OF EXISTING BOILER | 1 | JOB | 60.0 | 22.91 | $1,375 | 14,000.00 | $14,000 | $15,375 |
| SUBTOTAL FROM PAGE 2 | | | | | 31,584 | | 174,665 | 206,249 |
| SUBTOTAL FROM PAGE 3 | | | | | 7,487 | | 25,332 | 32,819 |
| | | | | SUBTOTAL | 54,641 | | 213,997 | 268,638 |
| | | | | O & P @ 20% | 10,928 | | 42,799 | 53,727 |
| | | | | SUBTOTAL | 65,569 | | 256,796 | 322,365 |
| | | | | DESIGN @ 6% | | | | 19,342 |
| | | | | SUBTOTAL | | | | 341,707 |
| | | | | SIOH @ 5.5% | | | | 18,794 |
| | | | | NMGRT @ 6% | | | | 20,502 |
| | | | | AREA ADJUST. @ 10% | | | | 34,171 |
| | | | | TOTAL | | | | $415,174 |

**HUITT-ZOLLARS, INC.**
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - LSTC

**PROJECT NO:** 03-0185.05 **DATE:** 7/24/96

**ECO NO. F**

**BY :** KOTHMAN, K. **CHECKED BY:** HOWARD, D.

**PROJECT DESCRIPTION:** Chiller Retrofit

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| INSTALL THE FOLLOWING : | | | | | | | | |
| CHILLER CH-1 (YORK) 50 TON R-22 | 1 | EA | 135 | 22.91 | $3,093 | 22,800.00 | $22,800 | $25,893 |
| CHILLER CH -2 (YORK) 180 TON R-123 | 1 | EA | 533 | 22.91 | $12,211 | 58,000.00 | $58,000 | $70,211 |
| CHILLER CH -3 (YORK) 180 TON R-123 | 1 | EA | 533 | 22.91 | $12,211 | 58,000.00 | $58,000 | $70,211 |
| HW BOILER B-1 (AERCO - PROPANE) 1000 MBH | 1 | EA | 34 | 22.91 | $779 | 13,850.00 | $13,850 | $14,629 |
| BOILER BREECHING - STAINLESS STEEL | 50 | LF | 0.9 | 22.91 | $1,031 | 147.00 | $7,350 | $8,381 |
| FLUE DRAFT ASSIST FAN, 250 CFM, APPROX. 1.0 IN. SP. | 1 | EA | 6.5 | 22.91 | $149 | 515.00 | $515 | $664 |
| HEATING WTR PUMP P-5 3/4 HP | 1 | EA | 5.18 | 22.91 | $119 | 800.00 | $800 | $919 |
| CHILLED WTR PUMP P-7A 5 HP | 1 | EA | 8.1 | 22.91 | $186 | 1,250.00 | $1,250 | $1,436 |
| CHILLED WTR PUMP P-7B 15 HP | 1 | EA | 14.4 | 22.91 | $330 | 2,350.00 | $2,350 | $2,680 |
| CHILLED WTR PUMP P-7C 15 HP | 1 | EA | 14.4 | 22.91 | $330 | 2,350.00 | $2,350 | $2,680 |
| COND WTR PUMP P-10A 10 HP | 1 | EA | 14.0 | 22.91 | $321 | 1,800.00 | $1,800 | $2,121 |
| COND WTR PUMP P-10B 20 HP | 1 | EA | 18.0 | 22.91 | $412 | 2,800.00 | $2,800 | $3,212 |
| COND WTR PUMP P-10C 20 HP | 1 | EA | 18.0 | 22.91 | $412 | 2,800.00 | $2,800 | $3,212 |
| SUBTOTAL PAGE 2 | | | | | 31,584 | | 174,665 | 206,249 |
| | | | | SUBTOTAL | | | | |
| | | | | O & P @ 20% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | DESIGN @ 6% | | | | |
| | | | | SUBTOTAL | | | | |
| | | | | SIOH @ 5.5% | | | | |
| | | | | NMGRT @ 6% | | | | |
| | | | | AREA ADJUST. @ 10% | | | | |
| | | | | TOTAL | | | | |

**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

# ENGINEER'S ESTIMATE OF PROBABLE COST

LOCATION: HELSTF - LSTC

ECO NO. F

PROJECT NO: 03-0185.05

DATE: 7/24/96

BY : KOTHMAN, K.

CHECKED BY: HOWARD, D.

PROJECT DESCRIPTION: Chiller Retrofit

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| INSTALL THE FOLLOWING : | | | | | | | | |
| DUCT MNT REHEAT COIL LARGE 24X42 AVG DEMINSION | 17 | EA | 5.9 | 22.91 | $2,298 | 822.00 | $13,974 | $16,272 |
| DUCT MNT REHEAT COIL SMALL12X16 AVG DEMINSION | 22 | EA | 3.5 | 22.91 | $1,764 | 176.50 | $3,883 | $5,647 |
| RECONNECT ELECTRICAL | 1 | JOB | 40 | 22.91 | $916 | 150.00 | $150 | $1,066 |
| INSTALL CHEMICAL SYSTEM | 1 | JOB | 16.0 | 22.91 | $367 | 1,500.00 | $1,500 | $1,867 |
| CONNECT TO EMS SYSTEM | 1 | JOB | 10.5 | 22.91 | $241 | 875.00 | $875 | $1,116 |
| TEST, BALANCE AND START-UP | 1 | JOB | 40 | 22.91 | $916 | | | $916 |
| REFRIGERANT DETECTION SYSTEM AND VENTILATION | 1 | JOB | 41.0 | 22.91 | 939 | 4,100.00 | 4,100 | $5,039 |
| PROPANE GAS DETECTION SYSTEM AND ALARM | 1 | JOB | 2.0 | 22.91 | 46 | 850.00 | 850 | $896 |
| SUBTOTAL PAGE 3 | | | | | 7,487 | | 25,332 | 32,819 |

| | Labor Total | Unit Price | Material Total | Total Cost |
|---|---|---|---|---|
| SUBTOTAL | | | | |
| O & P @ 20% | | | | |
| SUBTOTAL | | | | |
| DESIGN @ 6% | | | | |
| SUBTOTAL | | | | |
| SIOH @ 5.5% | | | | |
| NMGRT @ 6% | | | | |
| AREA ADJUST. @ 10% | | | | |
| TOTAL | | | | |


HUITT-ZOLLARS, INC.

ENGINEERS / ARCHITECTS

512 MAIN STREET, SUITE 1500

FORT WORTH, TEXAS 76102-3922

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```
        Life Cycle Cost Analysis                   Study: HELSTF.LC
Energy Conservation Investment Program (ECIP)             LCCID FY96
Installation & Location: WSMR
Region data: NEW            Census Region:  4
Project NO. & Title: 03-0185.05 EEAP ENERGY STUDY - HELSTF FACILITY
Fiscal Year: 1997 Discrete Portion: ECO-F
Analysis Date: 08/16/96 Economic Life:  20  years
Prepared by: MICHAEL W. ELLIOTT, P.E., CEM
```

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | 377038 |
| B. SIOH | 18794 |
| C. Design Cost | 19342 |
| D. Total Cost (1A+1B+1C) | $415,174 |
| E. Salvage Value of Existing Equip. | $0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $415,174 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1995

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $25. | /Mbtus | 2,324 | Mbtus | $58,007 | 14.47 | $839,362 |
| Elec. Deman | | | | | $0 | 13.47 | $0 |
| Distillate | $. | /Mbtus | 0 | Mbtus | $0 | 17.01 | $0 |
| Residual Oi | $. | /Mbtus | 0 | Mbtus | $0 | 17.23 | $0 |
| Natural Gas | $. | /Mbtus | 0 | Mbtus | $0 | 17.32 | $0 |
| Coal | $. | /Mbtus | 0 | Mbtus | $0 | 14.04 | $0 |
| LPG | $6.5 | /Mbtus | -906 | Mbtus | -$5,853 | 15.64 | -$91,537 |
| Solar | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Geothermal | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Biomass | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Refuse | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Wind | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Other | $7. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| TOTAL | | | 1,418 | Mbtus | $52,154 | | $747,825 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| Exist. Chlr. R | $30,800 | 1 | .96 | $29,587 |
| R-11 Pump Down | -$4,000 | 1 | .96 | -$3,842 |
| ONE TIME TOTAL | $26,800 | | | $25,744 |
| TOTAL | $26,800 | | | $25,744 |

| | |
|---|---|
| 4. First Year Dollar Savings | $53,494 |
| 5. Simple Payback Period (Years) | 7.77 |
| 6. Total Net Discounted Savings | $773,569 |
| 7. Savings to Investment Ratio | 1.86 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 7.39% |

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | G |
| DATE: | 5/6/96 |
| ECO TITLE: | Replace Existing Centrifugal Chillers With New Electric Screw Chillers |
| INSTALLATION: | HELSTF, Bldg. TC-2 |
| LOCATION: | White Sands Missile Range, New Mexico |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 904 | MMBTU/yr |
| Diesel Energy Savings | 0 | MMBTU/yr |
| Total Energy Savings | 904 | MMBTU/yr |
| Total Cost Savings | 22,564 | $/yr |
| Total Investment | 248,890 | $ |
| Simple Payback | 9.65 | yrs |
| SIR | 1.57 | |

B. ECO Description:

Remove the two (2) existing 175 ton, R-11 centrifugal chillers (CH-51 or 52) and their controls in Building TC-2 and replace them with two (2) 180 ton, R-123 screw chillers (minimum full load KW/ton = 0.59). Reconnect the existing piping to the new chillers at the existing chillers' location. The two (2) existing 40 HP chilled water (CHW) pumps (P-51 and P-52) and piping shall remain, but both of the pump's impellers shall be trimmed down to handle the reduced flow in the system for the chillers. Reuse the existing 10 HP, two cell cooling tower (CT-51A & B). Reconfigure controls for two (2) primary 15 HP CND pumps (P-60 and P-61) such that they are decommissioned and left for future use if needed. Install 6" bypass line around primary CND pumps (P-60 and P-61), and close shut-off valves on supply and return lines to these pumps. Install two (2) new 15 HP vertical turbine pumps (P-67 & 68) in cooling tower sump and remove the two (2) existing 30 HP vertical turbine pumps (P-65 and P-66). Install controls such that either of the proposed vertical turbine pumps (P-67 & 68) operate with either of the new chillers (CH-51 & 52). All existing controls and electrical services should be reconnected where possible. All other systems and equipment shall remain as installed. Specific requirements in these areas should be determined by the design engineer responsible for this project. To meet the current ASHRAE Standard 15, a refrigerant detection and ventilation system shall be installed. Install new controls as required. Connect the new equipment to the building energy management system. This ECO will require engineering design drawings and specifications, as well as the system modifications as mentioned above.

C. Discussion:

The existing water cooled, centrifugal chillers in TC-2 were installed in 1982, and serve as the primary cooling system for the interface room, TC-1, and fluid transfer buildings. While only one chiller is required to handle the peak cooling load, the other was provided as a standby unit needed in the event of a shut-down of the primary chiller. The chillers appear to be in average to poor condition, highlighted by the fact that one of the chillers has had a compressor replaced, and both chillers have CND tubes which have been plugged for protection of the refigeration cycle. They both use R-11 refrigerant, which is no longer manufactured, as of January 1, 1996[1]. To avoid the anticipated increasing operational costs over the life of these machines, both of these chillers need to be retrofitted to use an approved refrigerant or replaced with new machines that operate on an approved refrigerant. These 14 year old machines have reached 70% of life expectancy and have

lost substantial efficiency. The estimated existing chiller input rating is 0.93 KW/ton at full load. Therefore, both chillers need to be replaced with more efficient screw chillers.

Screw chillers were selected over R-123 centrifugal chillers of the same size because of their first cost. In general, a centrifugal machine is more efficient yet also more costly. However, in this size range, both machines are approximately equal in the full range of efficiency, but the screw machine is approximately $15,000 less expensive. Moreover, a centrifugal chiller in the 180 ton capacity range, using refrigerant R-134a is not available (manufactured), hence this option was not evaluated The possibility of a direct gas fired absorption chiller was not evaluated due to the unavailability of natural gas at the facility. Lastly, preliminary evaluations of a steam operated absorption chiller showed it to be highly uneconomical for this building.

The existing condenser water system in TC-2 is unique in that the vertical turbine CND pumps at the cooling tower (P-65 and 66), sized at 1,425 GPM at 60 ft of head each, were designed to pump in series with two separate condenser water distribution loops, each having their own pumps. The first distribution loop utilized two (2) CND pumps (P-58 and 59) that provided water at approximately 85°F to cool some test equipment in the device rooms A and B, and on the test pallet in TC-1. Both pumps were sized for 900 GPM at 350 ft of head. The second distribution loop consisted of two (2) CND pumps (P-60 and 61) which serve chillers CH-51 and 52 in the TC-2 building. These pumps were sized for 525 GPM at 70 ft of head.

Because the CND water is no longer used to cool the test equipment mentioned previously, pumps P-58 and 59 have been decommissioned and valved off. Currently, pumps P-65 and P-66 operate in series with pumps P-60 and 61. This series pumping arrangement is a problem because the pumps at the cooling tower and the pumps serving the chillers are rated at different flow rates (1425 GPM vs. 525 GPM). Therefore, the cooling tower pumps are trying to move more water than the chiller pumps can handle, and the two are fighting each other. This condition is obviously very wasteful with respect to energy consumption. In order to relieve this wasteful situation, all four of these pumps will be decommissioned, and two (2) new vertical turbine pump will be installed at the cooling tower to service the CND loop at the rated flow of the new chillers.

The existing two cell cooling tower was originally selected to circulate 1,425 GPM per cell. With the installation of the new chillers, the new cooling tower water flow should not exceed 540 GPM at any time; thus, only one tower cell should be needed. This will reduce the wear on the tower such that each cell can be operated according to run-time.

D. Savings Calculations:

1. Energy Cost Savings:

The monthly peak demand and energy consumption of the HVAC systems before and after installation of the new chiller and pump were calculated using the Trace 600 computer program[2]. In order to account for previously derived savings, the lighting and HVAC systems from all previous ECOs were used as the initial conditions for this ECO. The computer models provided realistic energy usage profiles for both conditions. Field data obtained from the buildings were used to create these computer building models[3]. Once the computer simulations were completed, the total annual demand costs and energy consumptions of the existing and proposed HVAC systems were compared to determine the annual savings from this ECO. These savings calculations are shown on pages B-120 to B-121.

2. Maintenance Cost Savings:

By installing new chillers in place of the existing ones, the installation will save the cost of retrofitting the existing machines for the HCFC-123 refrigerant. This retrofit would be required in the near future due to the current restrictions on the R-11 refrigerant and future refrigerant price escalation. A simple retrofit of these chillers can involve replacing valves and gaskets and reprogramming controls. However, in a simple retrofit, the chiller can lose as much as 15-20 % in capacity and also increase the KW/ton of the machine. Therefore, to maintain the capacity within 5%; the gears need to also be replaced which can be quite expensive. The estimated cost of doing the latter retrofit is approximately $35,000 per chiller. This amounts to a total, one time maintenance cost savings of $70,000. This value was used in the life cycle cost analysis as a non-recurring savings in the first year of the ECO life.

E. Cost Estimate:

The total implementation cost for this ECO was estimatedon page B-122. Manufacturers data on the chiller and pumps is included in Appendix E (Volume II, Tab 5). This data was used to produce the estimated ECO implementation cost.

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the Life Cyde Cost In Design (LCCID) computer program, and data from the previously mentioned calculations. An item forthe savings of reclaiming R-11 refrigerant was input into the program based on $2.00 per pound and 2 pound per ton of chillers. This reclaim cost was added to a basic cost of $1,600 associated with removing the refrigerant from the machines. The summary sheet for the life cycle cost analysis is shown on page B-123. The "Other" fuel type shown in Section # 2 is for diesel fuel consumption. The results of the analysis are listed in the summary on page B-116.

## REFERENCES

1. Per EPA regulations.
2. See Appendix G (Volume II, Tab 7) for Trace 600 input and output data for this ECO.
3. See Appendix F (Volume II, Tab 6) for building field data used to create computer models.

PROPOSED HVAC EQUIPMENT LIST F[illegible] ECO-G: HELSTF Facility, Test Cell # 2
May 6, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | FULL LOAD | OPERATING TIMES | | | ANNUAL USE | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | HRS | DAYS | WKS | KWH | GAL |
| CH-51<br>Water Chiller | 1 | York YT Screw<br>180 ton, R-123 | chilled water | 106.0 KW | by computer model | | | 384,173 | |
| CH-52<br>Water Chiller | 1 | York YT Screw<br>180 ton, R-123 | chilled water | 106.0 KW | by computer model | | | 0 | |
| Pump P-51<br>Chilled Water | 1 | Lincoln<br>40 hp<br>393 gpm, 174' head | chilled water<br>CH-51 | 22.8 KW | by computer model | | | 199,728 | |
| Pump P-52<br>Chilled Water | 1 | Lincoln<br>40 hp<br>393 gpm, 174 ' hd | chilled water<br>CH-52 | 28.7 KW | by computer model | | | 0 | |
| Pump P-67<br>Condenser Water | 1 | Peerless Vertical Turbine Pump<br>Size 10MA, 1760 RPM<br>540 gpm, 75' head, 15 hp | condenser water<br>CH-51 | 10.3 KW | by computer model | | | 90,491 | |
| Pump P-68<br>Condenser Water | 1 | Peerless Vertical Turbine Pump<br>Size 10MA, 1760 RPM<br>540 gpm, 75' head, 15 hp | condenser water<br>CH-52 | 10.3 KW | by computer model | | | 0 | |
| Cooling Tower Fan<br>CT-51A | 1 | Existing<br>BAC model CFT-2420C | condenser water | 4.7 KW | by computer model | | | 36,782 | |
| Cooling Tower Fan<br>CT-51B | 1 | Existing<br>BAC model CFT-2420C | condenser water | 4.7 KW | by computer model | | | 0 | |

| ITEM | ECO-G TC-1 & TC-2 BUILDINGS, ECO-E LIGHTING & HVAC SYSTEMS MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 356,670 | |
| Chiller CH-51 | 37.7 | 38.7 | 49.6 | 56.2 | 63.9 | 71.5 | 76.0 | 74.3 | 66.1 | 56.2 | 38.4 | 38.0 | 400,851 | |
| Chiller CH-52 | | | | | | | | | | | | | | |
| Twr. Fan CT-51A | 4.0 | 4.2 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.4 | 4.1 | 37,372 | |
| Twr. Fan CT-51B | | | | | | | | | | | | | | |
| CHW Pump P-51 | 26.8 | 26.8 | 26.8 | 26.8 | 26.8 | 26.8 | 26.8 | 26.8 | 26.8 | 26.8 | 26.8 | 26.8 | 234,768 | |
| CHW Pump P-52 | | | | | | | | | | | | | | |
| CND Pump P-60 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 13.0 | 113,880 | |
| CND Pump P-61 | | | | | | | | | | | | | | |
| CND Pump P-65 | 21.6 | 21.6 | 21.6 | 21.6 | 21.6 | 21.6 | 21.6 | 21.6 | 21.6 | 21.6 | 21.6 | 21.6 | 189,216 | |
| CND Pump P-66 | | | | | | | | | | | | | | |
| Boiler B-51 | | | | | | | | | | | | | | 13,913 |
| Boiler B-52 | | | | | | | | | | | | | | |
| HW pump P-70 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 20,148 | |
| HW pump P-71 | | | | | | | | | | | | | | |
| HW pump P-63 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 55,188 | |
| HW pump P-64 | | | | | | | | | | | | | | |
| Fan AH-1 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 68,328 | |
| Fan AH-2 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 17,520 | |
| Fan AH-3 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 86,724 | |
| Fan AH-4 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 41,172 | |
| Fan AH-5 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 36,792 | |
| Fan AH-51 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 42,924 | |
| Fan AH-52 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 12,264 | |
| Fan AH-53 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 74,460 | |
| Fan AH-54 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 38,544 | |
| Fan AH-55 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 32,412 | |
| | | | | | | | | | | | | | | |
| Totals | 206.6 | 207.8 | 219.2 | 225.8 | 233.5 | 241.1 | 245.6 | 243.9 | 235.7 | 225.8 | 207.7 | 207.0 | 1,859,233 | 13,913 |

Total Energy 6,346 MMBTU/yr (electric)

Total Energy 1,391 MMBTU/yr (diesel)

| ITEM | ECO-G<br>TC-1 & TC-2 BUILDINGS, PROPOSED LIGHTING & HVAC SYSTEMS<br>MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 356,670 | |
| New Chiller CH-51 | 40.7 | 41.6 | 50.9 | 54.5 | 57.8 | 59.0 | 56.3 | 55.1 | 56.3 | 54.0 | 41.3 | 41.0 | 384,173 | |
| New Chiller CH-52 | | | | | | | | | | | | | | |
| Twr. Fan CT-51A | 3.8 | 4.0 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.3 | 3.9 | 36,782 | |
| Twr. Fan CT-51B | | | | | | | | | | | | | | |
| CHW Pump P-51 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 199,728 | |
| CHW Pump P-52 | | | | | | | | | | | | | | |
| CND Pump P-60 | | | | | | | | | | | | | | |
| CND Pump P-61 | | | | | | | | | | | | | | |
| CND Pump P-65 | | | | | | | | | | | | | | |
| CND Pump P-66 | | | | | | | | | | | | | | |
| New CND Pump P-67 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 90,491 | |
| New CND Pump P-68 | | | | | | | | | | | | | | |
| Boiler B-51 | | | | | | | | | | | | | | 13,913 |
| Boiler B-52 | | | | | | | | | | | | | | |
| HW pump P-70 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 20,148 | |
| HW pump P-71 | | | | | | | | | | | | | | |
| HW pump P-63 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 55,188 | |
| HW pump P-64 | | | | | | | | | | | | | | |
| Fan AH-1 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 68,328 | |
| Fan AH-2 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 17,520 | |
| Fan AH-3 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 86,724 | |
| Fan AH-4 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 41,172 | |
| Fan AH-5 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 36,792 | |
| Fan AH-51 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 42,924 | |
| Fan AH-52 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 12,264 | |
| Fan AH-53 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 74,460 | |
| Fan AH-54 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 38,544 | |
| Fan AH-55 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 32,412 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 181.1 | 182.2 | 192.2 | 195.8 | 199.1 | 200.3 | 197.6 | 196.4 | 197.6 | 195.3 | 182.2 | 181.5 | 1,594,320 | 13,913 |

Energy Savings 904 MMBTU/yr (electric)

Energy Savings MMBTU/yr (diesel)

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - Test Cell 2
**ECO NO.** G
**PROJECT NO:** 03-0185.05
**DATE:** 4/30/96
**BY:** KOTHMAN, K.
**CHECKED BY:** HOWARD, D.
**PROJECT DESCRIPTION:** Chiller Retrofit

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE THE FOLLOWING: | | | | | | | | |
| CHILLER CH-51 180 TON R-123 | 2 | EA | 133 | 22.91 | $6,094 | | | $6,094 |
| INSTALL THE FOLLOWING: | | | | | | | | |
| CHILLER CH-51 180 TON R-123 | 2 | EA | 533 | 22.91 | $24,422 | 58,000.00 | $116,000 | $140,422 |
| CONDENSER WTR PUMP 15 HP | 2 | EA | 14 | 22.91 | $641 | 2,350.00 | $4,700 | $5,341 |
| EXTEND PIPE MANIFOLD | 1 | LS | 30 | 22.91 | $687 | 1,200.00 | $1,200 | $1,887 |
| ELECTRICAL FEEDERS AND STARTERS | 1 | EA | 41 | 24.64 | $1,010 | 1,250.00 | $1,250 | $2,260 |
| REFRIGERANT DETECTION SYSTEM AND VENTILATION | 1 | JOB | 41.0 | 22.91 | 939 | 4,100.00 | 4,100 | $5,039 |
| SUBTOTAL | | | | | 33,793 | | 127,250 | 161,043 |
| O & P @ 20% | | | | | 6,759 | | 25,450 | 32,209 |
| SUBTOTAL | | | | | 40,552 | | 152,700 | 193,252 |
| DESIGN @ 6% | | | | | | | | 11,595 |
| SUBTOTAL | | | | | | | | 204,847 |
| SIOH @ 5.5% | | | | | | | | 11,267 |
| NMGRT @ 6% | | | | | | | | 12,291 |
| AREA ADJUST. @ 10% | | | | | | | | 20,485 |
| TOTAL | | | | | | | | $248,890 |

**HUITT-ZOLLARS, INC.**
**ENGINEERS / ARCHITECTS**
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

Life Cycle Cost Analysis                Study: HELSTF.LC
Energy Conservation Investment Program (ECIP)            LCCID FY96
Installation & Location: WSMR
Region data: NEW                Census Region: 4
Project NO. & Title: 03-0185.05 EEAP ENERGY STUDY - HELSTF FACILITY
Fiscal Year: 1997 Discrete Portion: ECO-G
Analysis Date: 08/20/96 Economic Life: 20 years
Prepared by: Michael W. Elliott, P.E., CEM

## ECIP Summary Report

1. Investment

| | |
|---|---|
| A. Construction Cost | $226,028 |
| B. SIOH | $11,267 |
| C. Design Cost | $11,595 |
| D. Total Cost (1A+1B+1C) | $248,890 |
| E. Salvage Value of Existing Equip. | 0 |
| F. Public Utility Company Rebate | $0 |
| G. Total Investment (1D-1E-1F) | $248,890 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1995

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $25. | /Mbtus | 904 | Mbtus | $22,564 | 14.47 | $326,499 |
| Elec. Deman | | | | | $0 | 13.47 | $0 |
| Distillate | $. | /Mbtus | 0 | Mbtus | $0 | 17.01 | $0 |
| Residual Oi | $. | /Mbtus | 0 | Mbtus | $0 | 17.23 | $0 |
| Natural Gas | $. | /Mbtus | 0 | Mbtus | $0 | 17.32 | $0 |
| Coal | $. | /Mbtus | 0 | Mbtus | $0 | 14.04 | $0 |
| LPG | $6.5 | /Mbtus | 0 | Mbtus | $0 | 15.64 | $0 |
| Solar | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Geothermal | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Biomass | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Refuse | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Wind | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Other | $7. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| TOTAL | | | 904 | Mbtus | $22,564 | | $326,499 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| Exist. C | $70,000 | 1 | .96 | $67,243 |
| R-11 Pum | -$2,800 | 1 | .96 | -$2,690 |
| ONE TIME TOTAL | $67,200 | | | $64,553 |
| TOTAL | $67,200 | | | $64,553 |

| | |
|---|---|
| 4. First Year Dollar Savings | $25,924 |
| 5. Simple Payback Period (Years) | 9.65 |
| 6. Total Net Discounted Savings | $391,052 |
| 7. Savings to Investment Ratio | 1.57 |
| If < 1, Project does not qualify | |
| 8. Adjusted Internal Rate of Return | 6.48% |

ENERGY CONSERVATION OPPORTUNITY (ECO)

| | |
|---|---|
| ECO NO: | H |
| DATE: | 5/6/96 |
| ECO TITLE: | Replace Existing Boiler With More Efficient Boiler and Remove Heat Exchanger |
| INSTALLATION: | HELSTF, TC-2 Building |
| LOCATION: | White Sands Missile Range, New Mexico |

A. Summary:

| | | |
|---|---|---|
| Electrical Energy Savings | 69 | MMBTU/yr |
| Diesel Energy Savings | 296 | MMBTU/yr |
| Total Energy Savings | 365 | MMBTU/yr |
| Total Cost Savings | 3,791 | $/yr |
| Total Investment | 30,559 | $ |
| Simple Payback | 8.06 | yrs |
| SIR | 1.73 | |

B. ECO Description:

Remove one (1) of the two existing 1,104 MBH, diesel fired HW boilers on the mezzanine of TC-2 Although the exterior insulation for the boiler is fiberglass, but the internal seal between the sections is asbestos rope. Therefore, the removal process must be coordinated with WSMR and the governing authorities. Install one (1) new, 80% minimum efficiency, 1200 MBH output, flex-tube, diesel fired HW boiler in the same location. Utilize the existing flue and feed-water piping. The second existing boiler shall remain in same location as a back-up boiler. Remove the existing heat exchanger (HX-54), two (2) primary HW pumps (P-70 & P-71), primary three-way valve and primary loop piping back to HW header at the boilers. Remove the secondary piping from heat exchanger, back to HW header at secondary loop pumps, P-63 and P-64. Remove HW expansion tank (T-51) on primary loop, and cap piping at take-off. Provide new 3" piping from HW supply header at the building pumps (P-63 & 64), and tie into HW supply header at the boilers. Purge the entire system (primary and secondary) and replace with a polypropylene glycol solution that has the following characteristics: it must be inhibited, it cannot contain petroleum based additives, and the solution must be less than 50% glycol. All other existing piping and controls shall remain wherever possible. Reuse the existing electrical distribution systems wherever possible. Install new controls as required. Connect the new equipment to the building energy management system. This ECO will require engineering design drawings and specifications, as well as the system modifications mentioned above.

C. Discussion:

The two (2) existing HW boilers in TC-2 (B-51 & B-52) were installed in 1982, and have a rated capacity of 1104 MBH and 80 GPM each. The boilers were designed with a 30°F temperature rise (220°F - 190°F), which is controlled by temperature sensors in the boiler water jacket. While only one boiler is needed to meet the peak heating load in the test cell area, the other boiler was provided as a standby unit.

The boilers are currently installed in parallel, in a primary-secondary configuration. The primary HW loop, between the boilers and the HX, currently operates between 180°F and 190°F. The two (2) 3 HP primary HW pumps (P-70 and P-71) were sized for a design head of 60 ft at a flow of 80 GPM. These pumps circulate HW through the primary loop, which includes the boiler and the shell side of the HX. The secondary loop, between the HX and the buildings, operates between 160°F and 180°F to serve the AHU coils, with an approximate 20°F temperature differential (180°F - 160°F). The two

(2) 5 HP secondary pumps (P-63 and P-64) were sized for 80 GPM at 110 ft head. These pumps circulate HW through the secondary loop, which includes the building AHUs and the tube side of the HX.

This original design was to isolate the primary and secondary systems for freeze protection. The primary loop would be HW only while the secondary loop contained a glycol solution. By replacing one of the existing inefficient boilers (65% efficiency) with a higher efficiency boiler (80% efficiency), and removing the HX and the primary HW pumps (P-70 & 71), both diesel savings and electrical demand and energy savings will occur. A polypropylene glycol solution is recommended over a ethylene glycol solution because the polypropylene glycol can be blown down into a conventional floor drain as opposed to treating the ethylene glycol solution as hazardous waste.

With the resistance of the HX and its piping removed, the two (2) existing building pumps (P-63 and 64) are capable of circulating required HW flow directly through the boilers. Also, with the installation of a new higher efficiency boiler, the new heating system efficiency will be approximately 80%. Refer to the new equipment list on page B-127 for the proposed heating system equipment specifications.

Natural gas fired boilers were not evaluated because natural gas is currently not available on-site. Therefore, the initial cost of providing this service would be uneconomical for this ECO. Propane fired boilers were evaluated but the energy savings calculated were canceled out by the higher fuel cost of propane and the requirement that both boilers would need to be replaced if propane fuel was used.

D. Savings Calculations:

1. Energy Cost Savings:

The monthly peak demand and energy consumption of the HVAC systems before and after the installation of the new boiler and the removal of the heat exchanger and primary pumps were calculated using the Trace 600 computer program[1]. To account for previously derived savings, the lighting and HVAC systems from all previous ECOs were used as the initial conditions for this ECO. The computer models provided realistic energy usage profiles for both conditions. Field data obtained from the buildings were used to create these computer building models[2].

Once the computer simulations were completed, the total annual demand costs and energy consumptions of the initial and proposed HVAC systems were compared to determine the annual savings from this ECO. These savings calculations are shown on pages B-128 to B-129.

2. Maintenance Cost Savings:

According to the maintenance personnel at the facility, there has been very little maintenance above the normal required for these boilers. Therefore, there was no maintenance savings associated with this ECO.

E. Cost Estimate:

The total implementation costs for this ECO were estimated on page B-130. Manufacturers data on the boiler is included in Appendix E (Volume II, Tab 5). This data was used to produce the estimated

ECO implementation cost.

F. Life Cycle Cost Analysis:

A life cycle cost analysis was performed on this ECO using the program LCCID and data from the above calculations. The summary sheet for the life cycle cost analysis is shown on page B-131. The "Other" fuel type shown in Section # 2 is for diesel fuel consumption. Results of the analysis are listed in the summary on page B-124.

## REFERENCES

1. See Appendix G (Volume II, Tab 7) for Trace 600 input and output data for this ECO.

2. See Appendix F (Volume II, Tab 6) for building field data used to create computer models.

PROPOSED HVAC EQUIPMENT LIST FOR ECO-H: HELSTF Facility, Test Cell # 2
April 2, 1996

| ITEM | QTY. | DESCRIPTION | AREA SERVED | FULL LOAD | OPERATING TIMES | | | ANNUAL USE | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | HRS | DAYS | WKS | KWH | GAL |
| B-51<br>HW Boiler<br>Diesel Fired | 1 | Bryan CL-90FOO<br>720 MBH out, 180F HW | heating water | 6.50 GPH | by computer model | | | | 10,954 |
| B-52<br>HW Boiler<br>Diesel Fired | 1 | Weil-Mclain model 786<br>forced draft firebox<br>1226 MBH out | heating water<br>TC-1 building | 12.15 GPH<br>0.8 KVA-475 V | by computer model | | | | 0 |
| Pump P-63<br>Heating Water | 1 | U.S. Electric Motor<br>7.5 HP<br>80 gpm, 110' hd | heating water<br>B-51 & building | 6.3 KW | by computer model | | | 55,188 | |
| Pump P-64<br>Heating Water | 1 | U.S. Electric Motor<br>7.5 HP<br>80 gpm, 110' hd | heating water<br>TC-1 building | 7.1 KW | by computer model | | | 0 | |

| ITEM | ECO-H<br>TC-1 & TC-2 BUILDINGS, ECO-G LIGHTING & HVAC SYSTEMS<br>MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 356,670 | |
| Chiller CH-51 | 40.7 | 41.6 | 50.9 | 54.5 | 57.8 | 59.0 | 56.3 | 55.1 | 56.3 | 54.0 | 41.3 | 41.0 | 384,173 | |
| Chiller CH-52 | | | | | | | | | | | | | | |
| Twr. Fan CT-51A | 3.8 | 4.0 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.3 | 3.9 | 36,782 | |
| Twr. Fan CT-51B | | | | | | | | | | | | | | |
| CHW Pump P-51 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 199,728 | |
| CHW Pump P-52 | | | | | | | | | | | | | | |
| CND Pump P-60 | | | | | | | | | | | | | | |
| CND Pump P-61 | | | | | | | | | | | | | | |
| CND Pump P-65 | | | | | | | | | | | | | | |
| New CND Pump P-66 | | | | | | | | | | | | | | |
| Boiler B-51 | | | | | | | | | | | | | | 13,913 |
| Boiler B-52 | | | | | | | | | | | | | | |
| HW pump P-70 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 20,148 | |
| HW pump P-71 | | | | | | | | | | | | | | |
| HW pump P-63 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 55,188 | |
| HW pump P-64 | | | | | | | | | | | | | | |
| Fan AH-1 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 68,328 | |
| Fan AH-2 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 17,520 | |
| Fan AH-3 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 86,724 | |
| Fan AH-4 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 41,172 | |
| Fan AH-5 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 36,792 | |
| Fan AH-51 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 42,924 | |
| Fan AH-52 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 12,264 | |
| Fan AH-53 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 74,460 | |
| Fan AH-54 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 38,544 | |
| Fan AH-55 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 32,412 | |
| | | | | | | | | | | | | | | |
| Totals | 170.8 | 171.9 | 181.9 | 185.5 | 188.8 | 190.0 | 187.3 | 186.1 | 187.3 | 185.0 | 171.9 | 171.2 | 1,503,829 | 13,913 |

Total Energy 5,133 MMBTU/yr (electric)

Total Energy 1,391 MMBTU/yr (diesel)

| ITEM | ECO-H<br>TC-1 & TC-2 BUILDINGS, PROPOSED LIGHTING & HVAC SYSTEMS<br>MONTHLY PEAK DEMAND (KW) | | | | | | | | | | | | ANNUAL ENERGY USAGE (KWH) | ANNUAL DIESEL USAGE (THERM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
| Lighting Systems | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 43.4 | 356,670 | |
| New Chiller CH-51 | 40.7 | 41.6 | 50.9 | 54.5 | 57.8 | 59.0 | 56.3 | 55.1 | 56.3 | 54.0 | 41.3 | 41.0 | 384,173 | |
| Chiller CH-52 | | | | | | | | | | | | | | |
| Twr. Fan CT-51A | 3.8 | 4.0 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.3 | 3.9 | 36,782 | |
| Twr. Fan CT-51B | | | | | | | | | | | | | | |
| CHW Pump P-51 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 199,728 | |
| CHW Pump P-52 | | | | | | | | | | | | | | |
| CND Pump P-60 | | | | | | | | | | | | | | |
| CND Pump P-61 | | | | | | | | | | | | | | |
| CND Pump P-65 | | | | | | | | | | | | | | |
| CND Pump P-66 | | | | | | | | | | | | | | |
| New Boiler B-51 | | | | | | | | | | | | | | 10,954 |
| Boiler B-52 | | | | | | | | | | | | | | |
| HW pump P-70 | | | | | | | | | | | | | | |
| HW pump P-71 | | | | | | | | | | | | | | |
| HW pump P-63 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 55,188 | |
| HW pump P-64 | | | | | | | | | | | | | | |
| Fan AH-1 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 68,328 | |
| Fan AH-2 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 17,520 | |
| Fan AH-3 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 86,724 | |
| Fan AH-4 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 41,172 | |
| Fan AH-5 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 36,792 | |
| Fan AH-51 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 42,924 | |
| Fan AH-52 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 12,264 | |
| Fan AH-53 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 74,460 | |
| Fan AH-54 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 38,544 | |
| Fan AH-55 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 32,412 | |
| | | | | | | | | | | | | | | |
| Total (KW) | 168.5 | 169.6 | 179.6 | 183.2 | 186.5 | 187.7 | 185.0 | 183.8 | 185.0 | 182.7 | 169.6 | 168.9 | 1,483,681 | 10,954 |

Energy Savings 69 MMBTU/yr (electric)

Energy Savings 296 MMBTU/yr (diesel)

# ENGINEER'S ESTIMATE OF PROBABLE COST

**LOCATION:** HELSTF - Test Cell 2

**ECO NO. H**

**PROJECT NO:** 03-0185.05 **DATE:** 7/24/96

**BY:** KOTHMAN, K. **CHECKED BY:** HOWARD, D.

**PROJECT DESCRIPTION:** Boiler Retrofit

| ITEM DESCRIPTION | QUANTITY | | LABOR | | | MATERIAL | | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| | # of Units | Unit Meas. | Hrs / Unit | Rate | Total | Unit Price | Total | |
| REMOVE THE FOLLOWING: | | | | | | | | |
| EXISTING BOILER, HEAT EXCHANGER, AND PRIMARY PUMPS | 1 | JOB | 80 | 22.91 | $1,833 | 2,500.00 | $2,500 | $4,333 |
| ELECTRICAL DEMOLITION | 1 | EA | 3.5 | 24.64 | $86 | 25.00 | $25 | $111 |
| INSTALL THE FOLLOWING: | | | | | | | | |
| NEW BOILER OIL FIRED 1200 MBH-OUT | 1 | EA | 50 | 22.91 | $1,146 | 10,000.00 | $10,000 | $11,146 |
| NEW BOILER BEACHING | 1 | LS | 20 | 22.91 | $458 | 800.00 | $800 | $1,258 |
| EXTEND PIPE MANIFOLD | 1 | LS | 35 | 22.91 | $802 | 1,150.00 | $1,150 | $1,952 |
| POLYPROPYLENE GLYCOL REPLACEMENT | 1 | JOB | 25 | 22.91 | $573 | 400.00 | $400 | $973 |
| | | | | SUBTOTAL | 4,898 | | 14,875 | 19,773 |
| | | | | O & P @ 20% | 980 | | 2,975 | 3,955 |
| | | | | SUBTOTAL | 5,878 | | 17,850 | 23,728 |
| | | | | DESIGN @ 6% | | | | 1,424 |
| | | | | SUBTOTAL | | | | 25,152 |
| | | | | SIOH @ 5.5% | | | | 1,383 |
| | | | | NMGRT @ 6% | | | | 1,509 |
| | | | | AREA ADJUST. @ 10% | | | | 2,515 |
| | | | | TOTAL | | | | $30,559 |

**HUITT-ZOLLARS, INC.**
ENGINEERS / ARCHITECTS
512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102-3922
(817) 335-3000 * FAX (817) 335-1025

Life Cycle Cost Analysis                    Study: HELSTF.LC
Energy Conservation Investment Program (ECIP)                    LCCID FY96
Installation & Location: WSMR
Region data: NEW MEXICO     Census Region: 4
Project NO. & Title: 03-0185.05 EEAP ENERGY STUDY - HELSTF FACILITY
Fiscal Year: 1996 Discrete Portion: ECO-H
Analysis Date: 07/24/96 Economic Life: 20 years
Prepared by: JOHN CARTER

## ECIP Summary Report

1. Investment

| | | |
|---|---|---|
| A. | Construction Cost | 27752 |
| B. | SIOH | 1383 |
| C. | Design Cost | 1424 |
| D. | Total Cost (1A+1B+1C) | $30,559 |
| E. | Salvage Value of Existing Equip. | $0 |
| F. | Public Utility Company Rebate | $0 |
| G. | Total Investment (1D-1E-1F) | $30,559 |

2. Energy Savings (+) / Costs (-)
Date of NISTIR 85-3273-X used for Discount Factors Oct 1995

| Fuel | Price | Price Units | Usage Savings | Usage Units | Annual Savings | Discount Factor | Discounted Savings |
|---|---|---|---|---|---|---|---|
| Electricity | $25. | /Mbtus | 69 | Mbtus | $1,722 | 14.47 | $24,921 |
| Elec. Deman | | | | | $0 | 13.47 | $0 |
| Distillate | $. | /Mbtus | 0 | Mbtus | $0 | 17.01 | $0 |
| Residual Oi | $. | /Mbtus | 0 | Mbtus | $0 | 17.23 | $0 |
| Natural Gas | $. | /Mbtus | 0 | Mbtus | $0 | 17.32 | $0 |
| Coal | $. | /Mbtus | 0 | Mbtus | $0 | 14.04 | $0 |
| LPG | $6.5 | /Mbtus | 0 | Mbtus | $0 | 15.64 | $0 |
| Solar | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Geothermal | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Biomass | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Refuse | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Wind | $. | /Mbtus | 0 | Mbtus | $0 | 13.47 | $0 |
| Other | $7. | /Mbtus | 296 | Mbtus | $2,069 | 13.47 | $27,870 |
| TOTAL | | | 365 | Mbtus | $3,791 | | $52,791 |

3. Non Energy Savings (+) / Costs (-)

| Item | Savings/ Cost | Year | Discount Factor | Discounted Savings/Cost |
|---|---|---|---|---|
| ANNUAL TOTAL | $0 | | | $0 |
| ONE TIME TOTAL | $0 | | | $0 |
| TOTAL | $0 | | | $0 |

| | | |
|---|---|---|
| 4. | First Year Dollar Savings | $3,791 |
| 5. | Simple Payback Period (Years) | 8.06 |
| 6. | Total Net Discounted Savings | $52,791 |
| 7. | Savings to Investment Ratio | 1.73 |
| | If < 1, Project does not qualify | |
| 8. | Adjusted Internal Rate of Return | 6.98% |

APPENDIX D
SCOPE OF WORK AND REVIEW COMMENTS

TABLE OF CONTENTS

**DETAILED SCOPE OF WORK**
**CONTRACT NO. DACAC63-94-D-0015**
**DELIVERY ORDER NO. 0009**

1. The Architect-Engineer (A-E) shall furnish all services, material, supplies, plant, labor, equipment, investigations, studies, superintendence and travel as required in connection with the below identified project for design in accordance with the original basic contract and this Detailed Scope of Work. Appendix "A" of the basic contract shall be followed for performance requirements for A-E services. Where this Detailed Scope of Work conflicts with Appendix "A", this Detailed Scope of Work shall govern.

| INSTALLATION | PROJECT TITLE |
|---|---|
| White Sands Missile Range, NM | Limited Energy Study, Helstf, (EEAP) |

2. The work and other related data and services required in this Delivery Order shall be accomplished within the time schedule required, in accordance with the subject stated above and scope of work described in paragraph 3 below. The schedule for delivery of data to the Contracting Officer is in calendar days as follows:

| | | DELIVERY SCHEDULE |
|---|---|---|
| a. | Interim Submittal and related data for studies (See Annex A for number of copies) | 100 calendar days after receipt of signed D.O. |
| b. | Pre-Final Submittal(s) (12 copies) | 40 calendar days after approval of Interim submittal |
| c. | Final Submittal (original and all data developed under this submittal) | 40 calendar days after approval of the pre-final |

3. The items of work included in this Delivery Order shall be in accordance with criteria furnished at the Scoping conference held 24 May 1995 at White Sands Missile Range, NM. The services to be provided shall include, but not be limited to, the following:

a. Items of Work: (See the enclosed General and Detailed Scope of Work).

1. <u>BRIEF DESCRIPTION OF WORK</u>: The Architect-Engineer (AE) shall:

1.1 Perform a site survey of specific facilities to collect all data required to perform a thorough energy audit of the facilities.

1.2 Identify and evaluate Energy Conservation Opportunities (ECOs) to determine their energy savings potential and economic feasibility.

1.3 Provide project documentation for recommended ECOs as detailed herein.

1.4 Prepare a comprehensive report to document all work performed, the results and all recommendations.

2. <u>GENERAL</u>

2.1 This study is limited to the evaluation of the specific buildings listed in Annex A, DETAILED SCOPE OF WORK.

2.2 The information and analysis outlined herein are considered to be minimum requirements for adequate performance of this study.

2.3 For the buildings listed in Annex A, all methods of energy conservation which are reasonable and practical shall be considered, including improvements of operational methods and procedures as well as the physical facilities. All ECOs which produce energy or dollar savings shall be documented in this report. Any ECO considered infeasible shall also be documented in the report with reasons for elimination.

2.4 The study shall consider the use of all energy sources applicable to each building, system, or ECO.

2.5 The "Energy Conservation Investment Program (ECIP) Guidance", described in letter from DAIM-FDF-U, dated 10 Jan 1994 establishes criteria for ECIP projects and shall be used for performing the economic analyses of <u>all</u> ECOs and projects. The program, Life Cycle Cost In Design (LCCID), has been developed for performing life cycle cost calculations in accordance with ECIP guidelines and is referenced in the ECIP Guidance. If any program other than LCCID is proposed for life cycle cost analysis, it must use the mode of calculation specified in the ECIP Guidance. The output must be in the format of the ECIP LCCA summary sheet, and it must be submitted for approval to the Contracting Officer.

2.6 Computer modeling will be used to analyze ECOs which would modify, replace, or significantly alter an existing heating, ventilating, and air-conditioning (HVAC) system. Modeling will be done using a professionally recognized and proven computer program or programs that integrate architectural features with air conditioning, heating, lighting and other energy-producing or consuming systems. These programs will be capable of simulating

the features, systems, and thermal loads of the building under study. The program will use established weather data files and may perform calculations on a true hour-by-hour basis or may condense the weather files and the number of calculations into several "typical" days per month. The Detailed Scope of Work, Annex A, lists programs that are acceptable to the Contracting Officer. If the AE desires to use a different program, it must be submitted for approval with a sample run, an explanation of all input and output data, and a summary of program methodology and energy evaluation capabilities.

2.7 Energy conservation opportunities determined to be technically and economically feasible shall be developed into projects acceptable to installation personnel. This may involve combining similar ECOs into larger packages which will qualify for ECIP funding, and determining in coordination with installation personnel the appropriate packaging and implementation approach for all feasible ECOs.

2.7.1 Projects which qualify for ECIP funding shall be identified, separately listed, and prioritized by the Savings to Investment Ratio (SIR).

2.7.2 All feasible non-ECIP projects shall be ranked in order of highest to lowest SIR.

2.8 Metric Reporting Requirements: In this study, the analyses of the ECOs may be performed using English or Metric units as long as they are consistent throughout the report. The final results of energy savings for individual recommended projects and for the overall study will be reported in units of MegaBTU per year <u>and</u> in MegaWattHours per year. Paragraph 7.4.2 details requirements for the contents of the final submittal.

3. <u>PROJECT MANAGEMENT</u>

3.1 <u>Project Managers</u>. The AE shall designate a project manager to serve as a point of contact and liaison for work required under this delivery order. Upon award of this delivery order, the individual shall be immediately designated in writing. The AE's designated project manager shall be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for coordination of work required under this delivery order. The Contracting Officer will designate a project manager to serve as the Government's point of contact and liaison for all work required under this delivery order. This individual will be the Government's representative.

3.2 <u>Installation Assistance</u>. The Commanding Officer or authorized representative at the installation will designate an individual to assist the AE in obtaining information and establishing contacts necessary to accomplish the work required under this delivery order. This individual will be the installation representative.

3.3 Public Disclosures. The AE shall make no public announcements or disclosures relative to information contained or developed in this contract, except as authorized by the Contracting Officer.

3.4 Meetings. Meetings will be scheduled whenever requested by the AE or the Contracting Officer for the resolution of questions or problems encountered in the performance of the work. The AE's project manager and the Government's representative shall be required to attend and participate in all meetings pertinent to the work required under this contract as directed by the Contracting Officer. These meetings, if necessary, are in addition to the presentation and review conferences.

3.5 Site Visits, Inspections, and Investigations. The AE shall visit and inspect/investigate the site of the project as necessary and required during the preparation and accomplishment of the work.

3.6 Records

3.6.1 The AE shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with Government representative(s) relative to this contract in which the AE and/or designated representative(s) thereof participated. These records shall be dated and shall identify the contract number, and delivery order number, participating personnel, subject discussed and conclusions reached. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the records.

3.6.2 The AE shall provide a record of requests for and/or receipt of Government-furnished material, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of the work under this contract. The records shall be dated and shall identify the contract number and delivery order number. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the record of request or receipt of material.

4. SERVICES AND MATERIALS. All services, materials (except those specifically enumerated to be furnished by the Government), labor, supervision and travel necessary to perform the work and render the data required under this delivery order are included in the lump sum price of the delivery order.

5. PROJECT DOCUMENTATION. All energy conservation opportunities which the AE has considered shall be included in one of the following categories and presented in the report as such:

5.1 ECIP Projects. To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than $300,000, a Savings to Investment Ratio (SIR) greater than 1.25 and a simple payback period of less than ten years. The overall project and each discrete part of the

project shall have an SIR greater than 1.25. All projects meeting the above criteria shall be arranged as specified in paragraph 2.7.1 and shall be provided with programming documentation. Programming documentation shall consist of a DD Form 1391 and life cycle cost analysis (LCCA) summary sheet(s) (with necessary backup data to verify the numbers presented). A life cycle cost analysis summary sheet shall be developed for each ECO and for the overall project when more than one ECO are combined. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs.

5.2 Non-ECIP Projects. Projects which do not meet ECIP criteria with regard to cost estimate, but which have an SIR greater than 1.25 shall be documented. Projects or ECOs in this category shall be arranged as specified in paragraph 2.7.2 and shall be provided with the following documentation: the life cycle cost analysis (LCCA) summary sheet completely filled out, a description of the work to be accomplished, backup data for the LCCA, ie, energy savings calculations and cost estimate(s), and the simple payback period. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs. In addition these projects shall have the necessary documentation prepared, as required by the Government's representative, for one of the following categories:

a. Federal Energy Management Program (FEMP) Projects. A FEMP (or O&M Energy) project is one that results in needed maintenance or repair to an existing facility, or replaces a failed or failing existing facility, and also results in energy savings. The criteria are similar to the criteria for ECIP projects, ie, SIR $\geq$ 1.25, and simple payback period of less than ten years. Projects with a construction cost estimate up to $1,000,000 shall be documented as outlined in par 5.2 above; projects over $1,000,000 shall be documented on 1391s. In the FEMP program, a system may be defined as "failed or failing" if it is inefficient or technically obsolete. However, if this strategy is used to justify a proposed project, the equipment to be replaced must have been in use for at least three years.

b. Low Cost/No Cost Projects. These are projects which the Director of Public Works (DPW) can perform using his resources. Documentation shall be as required by the DPW.

5.3 Nonfeasible ECOs. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with reasons and justifications showing why they were rejected.

6. DETAILED SCOPE OF WORK. The Detailed Scope of Work is contained in Annex A.

7. WORK TO BE ACCOMPLISHED.

7.1 Perform a Limited Site Survey. The AE shall obtain all necessary data to evaluate the ECOs or projects by conducting a site survey. The AE shall document his site survey on forms

developed for the survey, or standard forms, and submit these completed forms as part of the report. All test and/or measurement equipment shall be properly calibrated prior to its use.

7.2 Evaluate Selected ECOs. The AE shall analyze all identified ECOs in detail to determine their feasibility. Savings to Investment Ratios (SIRs) shall be determined using current ECIP guidance. The AE shall provide all data and calculations needed to support the recommended ECO. All assumptions and engineering equations shall be clearly stated. Calculations shall be prepared showing how all numbers in the ECO were figured. Calculations shall be an orderly step-by-step progression from the first assumption to the final number. Descriptions of the products, manufacturers catalog cuts, pertinent drawings and sketches shall also be included. A life cycle cost analysis summary sheet shall be prepared for each ECO and included as part of the supporting data.

7.3 Combine ECOs Into Recommended Projects. During the Interim Review Conference, as outlined in paragraph 7.4.1, the AE will be advised of the DPW's preferred packaging of recommended ECOs into projects for implementation. Some projects may be a combination of several ECOs, and others may contain only one. These projects will be evaluated and arranged as outlined in paragraphs 5.1, 5.2, and 5.3. Energy savings calculations shall take into account the synergistic effects of multiple ECOs within a project and the effects of one project upon another. The results of this effort will be reported in the Final Submittal per par 7.4.2.

7.4 Submittals, Presentations and Reviews. The work accomplished shall be fully documented by a comprehensive report. The report shall have a table of contents and shall be indexed. Tabs and dividers shall clearly and distinctly divide sections, subsections, and appendices. All pages shall be numbered. Names of the persons primarily responsible for the project shall be included. The AE shall give a formal presentation of the interim submittal to installation, command, and other Government personnel. Slides or view graphs showing the results of the study to date shall be used during the presentation. During the presentation, the personnel in attendance shall be given ample opportunity to ask questions and discuss any changes deemed necessary to the study. A review conference will be conducted the same day, following the presentation. Each comment presented at the review conference will be discussed and resolved or action items assigned. It is anticipated that the presentation and review conference will require approximately one working day. The presentation and review conference will be at the installation on the date agreeable to the building occupant, the DPW, the AE and the Government's representative. The Contracting Officer may require a resubmittal of any document(s), if such document(s) are not approved because they are determined by the Contracting Officer to be inadequate for the intended purpose.

7.4.1 Interim Submittal. An interim report shall be submitted for review after the field survey has been completed and an analysis has been performed on all of the ECOs. The report shall indicate the work which has been accomplished to date, illustrate the methods and justifications of the approaches taken and contain a plan of the work remaining to complete the study. Calculations showing energy and dollar savings, SIR, and simple payback period of all the ECOs shall be included. The results of the ECO analyses shall be summarized by lists as follows:

a.All ECOs eliminated from consideration shall be grouped into one listing with reasons for their elimination as discussed in par 5.3.

b.All ECOs which were analyzed shall be grouped into two listings, recommended and non-recommended, each arranged in order of descending SIR. The AE shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing the work and results to date shall be a part of this submittal. At the Interim Submittal and Review Conference, the Government's and AE's representatives shall coordinate with the DPW to provide the AE with direction for packaging or combining ECOs for programming purposes and also indicate the fiscal year for which the programming or implementation documentation shall be prepared. The survey forms completed during this audit shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they are to be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within.

7.4.2 Final Submittal. The AE shall prepare and submit the final report when all sections of the report are 100% complete and all comments from the interim submittal have been resolved. The AE shall submit the Scope of Work for the study, any modifications to the Scope of Work, and responses to the interim review comments as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The recommended projects, as determined in accordance with paragraph 5, shall be presented in order of priority by SIR. The lists of ECOs specified in paragraph 7.4.1 shall also be included for continuity. The final report and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The final report shall be arranged to include:

a. An Executive Summary to give a brief overview of what was accomplished and the results of this study using graphs, tables and charts as much as possible (See Annex B for minimum requirements).

b. The narrative report describing the problem to be studied, the approach to be used, and the results of this study.

c. Documentation for the recommended projects (includes LCCA Summary Sheets).

d. Appendices to include as a minimum:

1) Energy cost development and backup data

2) Detailed calculations

3) Cost estimates

4) Computer printouts (where applicable)

5) Scope of Work

ANNEX A

DETAILED SCOPE OF WORK

LIMITED ENERGY STUDY

HELSTF FACILITY

WHITE SANDS MISSILE RANGE, NM

1. The General Scope of Work outlines requirements for the study and the report; and the detailed scope of work describes the specific area to be studied. If any conflicts arise between the General and the Detailed scopes of work, the Detailed Scope of Work shall govern.

2. The High Energy Laser Systems Test Facility (HELSTF) is located just north of US Highway 70, approximately twenty-two miles northeast of the main post of White Sands Missile Range. Two HELSTF buildings are included in this study, Building 26129 and Building 26199. Access to the site is controlled. Temporary passes will be required for both personnel and vehicle access. A one-week notice should be given by the AE prior to any visit. This time will be needed to make the necessary arrangements for the visit.

3. The installation representative for this contract will be Mr. Julian Delgado, Energy Manager, Directorate of Public Works. The occupant representative will be Mr. Robert Anderson, HELSTF Facility Engineer.

4. The HELSTF comes under the US Army Space and Strategic Defense Command (SSDC). The HELSTF is a tenant on White Sands Missile Range (WSMR). The HELSTF site is separately metered, and SSDC reimburses WSMR for electrical energy used at a melded rate of $.083/Kwh.

5. Both buildings were constructed approximately 1966 as research and development facilities, housing large amounts of electronic equipment and computers. They were remodeled for their current mission in 1982. The occupancy and the HVAC loads have changed since the buildings were constructed. HVAC equipment is old, and HVAC controls are becoming obsolete. Lighting systems do not meet current standards with respect to energy efficiency. The purpose of this study is to find all cost-effective measures which may be employed to reduce energy consumption and cost.

a. Building 26129 is a 90,000 square-foot, dome-shaped facility, mostly below grade. It is utilized as the site operations control center, and it also houses offices and shops. Some spaces require temperature and humidity control, some require year-round cooling. Full-time occupancy is light, but it can increase during tests. Cooling is accomplished with two 120-ton, open, centrifugal chillers with heat recovery. Hot water for heating is recovered from the chillers. When the building was remodled, all of the original air handlers were left in place; and they are still in

use. There may be opportunities for consolidating or modifying the air handling systems.

b. Building 26199 is an 18,000 square-foot facility housing a high-energy laser, beam director, optical diagnostic equipment, and test suites. This building has been extensively modified and expanded from its original design. Part of it is operated as a "clean" area, with strict temperature, humidity, and delta-p requirements. There are multiple air handlers, some serving overlapping areas. Two chillers, two hot water boilers, and a steam boiler which serve this building are located in an adjacent building. The boilers are oil-fired and in poor condition; they should be evaluated for replacement, and LP gas should be evaluated as a possible fuel.

6. The work consists of conducting a thorough energy audit to identify and evaluate energy conservation opportunities (ECOs) for Buildings 26129, 26199, and any remote equipment that serves these buildings. All energy-related aspects of the facility should be investigated, ie, lighting; HVAC systems, equipment and controls; other equipment, operations, and maintenance. Field data taken should include lighting levels and operating amps of all major equipment. Any proposal that would modify or replace the chillers must take into consideration the latest guidance on CFC refrigerants. See suggested ECOs at the end of this annex.

7. Completion and Payment Schedule: The following schedule shall be used as a guide in approving payments on this contract. The final report for this study shall be due not later than 180 days after Notice to Proceed.

| MILESTONE | PERCENT OF CONTRACT AMOUNT AUTHORIZED FOR PAYMENT |
|---|---|
| Completion of Field Work | 25 |
| Receipt of Interim Submittal | 75 |
| Completion of Interim Presentation & Review | 85 |
| Receipt of Final Report | 100 |

8. The following computer programs will be acceptable for use in building and HVAC system simulation. If it is desired to use a program other than one of the following, it must be submitted for approval as outlined in par 2.6 of the general scope of work.

a. Building Loads and System Thermodynamics (BLAST)
b. Carrier E20 or Hourly Analysis Program (HAP)
c. DOE 2.1B
d. Trane Air-Conditioning Economics (TRACE)

9. Government-Furnished Information: The following documents will be furnished to the AE:

a. As-built drawings of Buildings 26129 & 26199.

b. Energy consumption records.

c. Energy Conservation Investment Program (ECIP) Guidance, dated 10 Jan 1994.

d. ETL 1110-3-254, Use of Electric Power for Comfort Space Heating

e. ETL 1110-3-282, Energy Conservation

f. TM 5-785, Engineering Weather Data

g. TM 5-800-2, Cost Estimates, Military Construction

h. AR 415-15, 1 Jan 84, Military Construction, Army (MCA) Program Development

i. Architectural and Engineering Instructions, Design Criteria, 18 September 1992

j. The latest MCP Index

10. A computer program titled Life Cycle Costing in Design (LCCID) is available from the BLAST Support Office in Urbana, Illinois for a nominal fee. The current edition of LCCID is dated October 1994. This computer program can be used for performing the economic calculations for ECIP and non-ECIP ECOs. The AE is encouraged to obtain and use this computer program. The BLAST Support Office can be contacted at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana, Illinois 61801. The telephone number is (217) 333-3977 or (800) 842-5278.

11. Reports and correspondence shall be provided in the quantities shown to the offices listed below:

| | REPORT SUBMITTALS | *FIELD NOTES | CORRESPONDENCE |
|---|---|---|---|
| Commander<br>US Army White Sands Missile Range<br>ATTN: STEWS-DPW-PE (Mr. Delgado)<br>White Sands Missile Range, NM 88002-5076 | 2 | 1 | 1 |
| Commander<br>US Army Space and Strategic Defense Command<br>ATTN: CSSD-EN-F (Mr. Bennett)<br>PO Box 1500<br>Huntsville, AL, 35807-3801 | 1 | - | - |
| Commander<br>US Army Engineer District, Mobile<br>ATTN: CESAM-EN-DM (Mr. Battaglia)<br>PO Box 2288<br>Mobile, AL 36628-0001 | 1 | - | 1 |
| Commander<br>US Army Engineer District, Fort Worth<br>ATTN: CESWF-ED-MP (Mr Champagne)<br>PO Box 17300<br>Fort Worth, TX, 76102 - 0300 | 2 | 1 | 1 |
| Commander<br>U. S. Army Corps of Engineers<br>ATTN: CEMP-ET (Mr Gentil)<br>20 Massachusetts Avenue NW<br>Washington, DC, 20314 - 1000 | 1** | - | - |
| Commander<br>US Army Logistics Evaluation Agency<br>ATTN: LOEA-PL (Mr Keath)<br>New Cumberland Army Depot<br>New Cumberland, PA, 17070 - 5007 | 1** | - | - |

* To be submitted in final form with the interim submittal
** One copy of final Executive Summary only

## SUGGESTED ENERGY CONSERVATION OPPORTUNITIES

POWER

- o Improve power factor
- o High efficiency motor replacement

HOT WATER

- o Decentralize domestic hot water heaters
- o Instantaneous hot water heater(s)

HVAC

- o Reduce air flow
- o Night setback/setup thermostats
- o Economizer cycles (dry bulb)
- o Chiller replacement
- o Consolidate/revise air handling systems
- o Upgrade building HVAC controls

BOILERS/STEAM

- o Replace existing boilers with more efficient, low-maintenance boilers
- o Replace & reactivate abandoned boiler in Bldg 26129.

LIGHTING

- o Install occupancy sensors to control lighting
- o Upgrade exit sign lamps/fixtures
- o Replace standard fluorescent lamps with energy-conserving lamps
- o Replace standard fluorescent ballasts with electronic ballasts
- o Replace existing fluorescent fixtures with new fixtures having efficient reflectors, electronic ballasts, and energy-conserving lamps
- o Use more efficient lighting source, ie, upgrade from incandescent to fluorescent, from fluorescent to HID, from mercury vapor to high pressure sodium, etc

ANNEX B

## EXECUTIVE SUMMARY GUIDELINE

1. Introduction.

2. Building Data (types, number of similar buildings, sizes, etc.)

3. Present Energy Consumption of Buildings or Systems Studied.

   - Total Annual Energy Used.

   - Site Energy Consumption.

     Electricity - MWH, Dollars, MBTU<br>
     Fuel Oil - GALS, Dollars, MBTU & MWH<br>
     Natural Gas - THERMS, Dollars, MBTU & MWH<br>
     Propane - GALS, Dollars, MBTU & MWH<br>
     Other - QTY, Dollars, MBTU & MWH

4. Energy Conservation Analysis.

   - ECOs Investigated.
   - ECOs Recommended.
   - ECOs Rejected. (Provide economics or reasons)
   - ECIP Projects Developed. (Provide list)*
   - Non-ECIP Projects Developed. (Provide list)*
   - Operational or Policy Change Recommendations.

5. Energy and Cost Savings.

   - Total Potential Energy and Cost Savings resulting from recommended projects in MBTU/yr, MWH/yr, and $K/yr.
   - Percentage of Energy Conserved.
   - Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented.

* Include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date.

ANNEX C

## REQUIRED DD FORM 1391 DATA

To facilitate ECIP project approval, the following supplemental data shall be provided:

a. In title block clearly identify projects as "ECIP."

b. Complete description of each item of work to be accomplished including quantity, square footage, etc.

c. A comprehensive list of buildings, zones, or areas including building numbers, square foot floor area, designated temporary or permanent, and usage (administration, patient treatment, etc.).

d. List references, and assumptions, and provide calculations to support dollar and energy savings, and indicate any added costs.

(1) If a specific building, zone, or area is used for sample calculations, identify building, zone or area, category, orientation, square footage, floor area, window and wall area for each exposure.

(2) Identify weather data source.

(3) Identify infiltration assumptions before and after improvements.

(4) Include source of expertise and demonstrate savings claimed. Identify any special or critical environmental conditions such as pressure relationships, exhaust or outside air quantities, temperatures, humidity, etc.

e. Claims for boiler efficiency improvements must identify data to support present properly adjusted boiler operation and future expected efficiency. If full replacement of boilers is indicated, explain rejection of alternatives such as replace burners, nonfunctioning controls, etc. Assessment of the complete existing installation is required to make accurate determinations of required retrofit actions.

f. Lighting retrofit projects must identify number and type of fixtures, and wattage of each fixture being deleted and installed. New lighting shall be only of the level to meet current criteria. Lamp changes in existing fixtures is not considered an ECIP type project.

g. An ECIP life cycle cost analysis summary sheet as shown in the ECIP Guidance shall be provided for the complete project and for each discrete part included in the project. The SIR is applicable to all segments of the project. Supporting documentation consisting of basic engineering and economic calculations showing how savings were determined shall be included.

h. The DD Form 1391 face sheet shall include, for the complete project, the annual dollar and MBTU savings, SIR, simple amortization period and a statement attesting that all buildings and retrofit actions will be in active use throughout the amortization period.

i. The calendar year in which the cost was calculated shall be clearly shown on the DD Form 1391.

j. For each temporary building included in a project, separate documentation is required showing (1) a minimum 10-year continuing need, based on the installation's annual real property utilization survey, for active building retention after retrofit, (2) the specific retrofit action applicable and (3) an economic analysis supporting the specific retrofit.

k. Nonappropriated funded facilities will not be included in an ECIP project without an accompanying statement certifying that utility costs are not reimbursable.

l. Any requirements required by ECIP guidance dated 10 Jan 1994 and any revisions thereto. Note that unescalated costs/savings are to be used in the economic analyses.

m. The five digit category number for all ECIP projects except for Family Housing is 80000. The category code number for Family Housing projects is 71100.

HUITT-ZOLLARS

Huitt-Zollars, Inc. / Engineering / Architecture / 512 Main Street / Suite 1500 / Fort Worth, Texas 76102-3999 / Phone (817) 335-3000 / Fax (817) 335-1025

April 11, 1996

Mr. Noah Booker
ATTN: CESWF-ED-MR
US Army Corps of Engineers
P.O. Box 17300
Fort Worth, TX 76102-0300

RE: **LIMITED ENERGY STUDY, HELSTF, (EEAP)**
**WHITE SANDS MISSILE RANGE, NM**
**MARCH 6, 1996 "INTERIM REPORT REVIEW MEETING" MINUTES AND "REVIEW COMMENT" ANNOTATIONS**
**HZ PROJECT 03-185.05**

Dear Mr. Booker:

Transmitted herewith is one copy of the minutes of the referenced meeting and one copy of the review comment annotations.

It will be assumed that these meeting minutes are correct as stated unless notice to the contrary is brought to my attention within one week following receipt of this letter. If you have any questions or require further assistance on this subject, please let me know. Thanks!

Sincerely,

HUITT-ZOLLARS, INC.

Denney R Howard

Denney R. Howard, P.E.
Project Manager

DRH:ph

Enclosure(s)

cc: Julian Delgado, STEWS-DPW-PE, w/Enclosure(s)
Allen Bennett, CSSD-EN-F, w/Enclosure(s)
Anthony Battaglia, CESAM-EN-DM, w/Enclosure(s)
Larry Brooks, CSSD-HD, w/Enclosure(s)

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***** MEETING MINUTES *****

**MARCH 6, 1996 "INTERIM REPORT REVIEW MEETING"**

| | |
|---|---|
| CLIENT: | US ARMY CORPS OF ENGINEERS |
| PROJECT: | LIMITED ENERGY STUDY, HELSTF, (EEAP) |
| PROJECT NO.: | 03-0185.05 |

Following is the understanding of items discussed and decisions reached during this meeting. It will be assumed that this understanding is correct unless notice to the contrary is brought to the attention of the HZ Project Manager within one week following receipt of these minutes.

| | |
|---|---|
| HZ | = Huitt-Zollars, Inc. |
| COE | = US Army Corps of Engineers |
| HELSTF | = High Energy Laser System Test Facility |

**A. PURPOSE / ATTENDANCE**

1. Purpose:

   This meeting was held at HELSTF at White Sands Missile Range, NM and in general was a meeting for the purpose of presenting and discussing review comments for the project's interim report.

2. Attendance: (See the attached list.)

**B. DISCUSSION**

1. John Carter and Denney Howard, both with HZ, conducted a presentation of the Interim Report for the project.

2. The attendees to the meeting made introductions. (See the attached list.)

3. The project review comments were discussed. (See the attached review comment annotations.)

4. It was determined that the 1391 funding forms would be deferred to the Final Report. The ECO grouping will be determined by COE based on the results of the Pre-Final Report, which will incorporate the new utility cost data.

5. The Pre-Final Report will include an Executive Summary as outlined in the Detailed Scope of Work.

6. The Pre-Final Report submission will be due 40 calendar days after receipt of the notice to proceed by HZ.

END OF MEETING MINUTES

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06 March 1996

HELSTF

# HIGH ENERGY LASER SYSTEM TEST FACILITY

U.S. ARMY SPACE & STRATEGIC DEFENSE COMMAND

| NAME | ORG. | Ph #. |
|---|---|---|
| Denney Howard | Huitt-Zollars, Inc. | (817) 335-3000 |
| JOHN CARTER | HUTT ZOLLARS, INC. | " " " |
| FRANK TAPIA | AERO. | 5312 |
| Jim Rossen | Aerotherm | 679-5919 |
| Margaret Danae | Aerotherm | 679-5728 |
| Manuel Sandoval | Aerotherm | 5171 |
| Joe Proverrio | Aerotherm | 5944 |
| Ken Timblin | AeroTherm | 505-679-5314 |
| Julian T. Delgado | DPW-PE | 678-8762 |
| LARRY BROOKS | CSSD-HD | 679-5486 |
| Lionel Brown | CSSD-HD | 679-5709 |
| John Skipper | Aerotherm | 679 5839 |
| Ricardo Lucero | Aerotherm | 679-5574 |
| Scott King | Aerotherm | 679-5365 |
| Noah Booker, Jr. | Ft. Worth, TX | (817) 334-2763 |
| Anthony W. Battaglia | C of E, Mobile, AL | (334) 690-2618 |
| | | |

* * * * * REVIEW COMMENT ANNOTATIONS * * * * *

MARCH 6, 1996 "INTERIM REPORT"

| | |
|---|---|
| CLIENT: | US ARMY CORPS OF ENGINEERS |
| PROJECT: | LIMITED ENERGY STUDY, HELSTF, (EEAP) |
| PROJECT NO.: | 03-0185.05 |

Following are the annotations of project review comments discussed and decisions reached during the Interim Report review meeting. It will be assumed that this understanding is correct unless notice to the contrary is brought to the attention of the HZ Project Manager within one week following receipt of these minutes. The original review comments are included at the end of these annotations for reference.

| | |
|---|---|
| HZ | = Huitt-Zollars, Inc. |
| COE | = US Army Corps of Engineers |
| HELSTF | = High Energy Laser System Test Facility |

**A. Anthony W. Battaglia, CESAM-EN-DM, 07 Feb. 96:**

1. No response required. Thank you for the comment.

2. Concur. This will be addressed in the Pre-Final Report.

3. a. Concur. Because HELSTF is one of several tenants on White Sands Missile Range, the metered usages for the entire base are used only as a benchmark for the estimated consumption for HELSTF.

   b. Concur. This will be addressed in the Pre-Final Report.

4. Concur. A melded rate of $0.0821 will be used in the Pre-Final Report.

5. Concur.

6. Concur. This applies to the LSTC and will be clarified in the Pre-final Report.

7. Concur. The sensors will be eliminated accordingly.

8. a. Concur.

   b. Concur. A cost will be added for refrigerant pump-down and disposal.

9. Concur.

10. Comment deleted by reviewer, since the cooling towers have recently been overhauled.

11. Concur. The ECO already pays back, but incorporation will aid the ECO.

12. Concur.

B. **Steve Ward for Allen Bennett, CSSD-EN-F, 01 Feb. 96:**

1. Exception. The listed rooms were typically locked and when entrance was obtained, several rooms were found to have the lights left on. Other rooms utilized unswitched lighting. For the purposes of this study, these spaces were assumed to have the lights on 24 hours a day. ECO-A should remain as is.

2. Concur. This will be included in the Pre-Final Report.

3. Concur. The "other" costs represent diesel fuel costs and are calculated from avoided costs for diesel fuel.

4. Concur. The "other" costs represent diesel fuel costs and are calculated from avoided costs for diesel fuel.

5. Concur. The "other" costs represent diesel fuel costs and are calculated from avoided costs for diesel fuel.

6. Concur. The "other" costs represent diesel fuel costs and are calculated from avoided costs for diesel fuel.

7. Concur. The "other" costs represent diesel fuel costs and are calculated from avoided costs for diesel fuel.

C. **Julian T. Delgado, STEWS-DPW-PE, 31 Jan 96:**

1. Concur.

2. Concur. Statement on page B-1 is accurate. The statement on page 4 will be revised.

3. Concur.

4. Exception. See page B-34, first paragraph under D. Savings Calculations.

5. Deleted by reviewer, since a melded rate will be incorporated.

6. Concur. We will incorporate the latest 1996 rate charges.

7. Concur.

8. Concur. Statement on page B-1 is accurate. The statement on page 4 will be revised.

9. Exception. Typically, a screw chiller is more efficient in the part load range of 25% to 50%. However, for a 180-ton chiller; the KW/ton for a centrifugal vs. a screw chiller is approximately the same throughout the part load operation. Moreover, the KW/ton for both of these types of chillers at a nighttime part load condition for the LSTC building is approximately 1.8. On the other hand, the first cost of a 180-ton screw chiller is cheaper than a centrifugal chiller of the same size. As a result, we recommend the smaller chiller to handle the nighttime load, and two larger screw

machines (one as back up) to handle the larger load. We will clarify this in the report.

10. Concur. In using the melded electrical rate, a new back up chiller can be purchased and still meet the requirements of a ten-year payback and a SIR greater than 1.0.

11. Concur. The electrical consumptions as appearing in Appendices 6 and 7 will be coordinated to match each other. However, it needs to be pointed out that the lighting consumption for the buildings as shown in Appendix 7 will not exactly match the lighting consumptions as shown in Appendix 6. The reason for this is that in modeling the areas as described in Tab 7 (Appendix G), Page G-3, Paragraph D, Comment # 4; operational schedules for multiple rooms were combined into one schedule which results in an "average" operational schedule for a particular area. This averaging, however, resulted in minimal differences in the consumptions as compared to Appendix 6. For example, the total difference in consumption between Appendix 6 and 7, for both ECO's A and B, was less than 2%. The electrical consumption for LSTC and Test Cells # 1 & 2 as shown on pages B-28 and B-30 appear to account for approximately half of the metered data shown in Figure 3 on Page 8.

12. Exception. A melded rate will be incorporated.

13. No response required. Thank you for the comment.

**D. George Culpepper, CESWF-ED-TM, 24 Jan 96:**

1. Exception. A melded rate will be incorporated.

2. Concur. We will incorporate the latest discount factors with the 1996 version of LCCID, and Region 4 will be used.

3. Concur. We believe that the estimate is valid; however, we will increase the labor rate and hours to reflect a higher cost as described.

4. Concur. Ranking ECO's by either simple payback or SIR usually produces the same ranking but not always. Our recommendations for implementing ECO's are the same as those that the HELSTF and maintenance personnel has recommended. We will include their recommendation in the Pre-Final report in tabular format. Moreover, the ECO's will be grouped into Projects in the Final report.

5. Concur. Refer to the response to comment # 4.

**E. Margaret Danao, Aerotherm, 09 Feb. 96:**

1. Deleted by reviewer and replaced with comments dated 1 March 1996.

**F. Facility Engineering, Aerotherm, 14 Feb. 96:**

1. Exception. Outside project Scope of Work.

2. Exception. The number of additional personnel working after hours is negligible as compared to normal operating hours. Therefore, shutting the general exhaust fan down during off hours will not affect the personnel in the building during that time. Moreover, the areas where the personnel will be working are cooled by computer room units which operate 24 hours/day.

G. **Facility Support Group, Aerotherm, 05 Feb. 96:**

1. Concur. We will recommend replacing the two boilers but not the heat exchanger.

2. Exception. EMS controls can be programmed to start the pump in the event the building calls for heating. However, with setback and hot/cold deck reset controls, the building should not need as much heating as it currently needs.

3. Concur.

4. Concur. We will include the cost and description of adding ventilation and refrigerant monitors as required by ASHRAE standards for chiller rooms.

5. Concur. The proposed EMS will include controls that will automatically enable and/or disable existing or proposed chillers when called for.

6. Concur. The proposed EMS will have cold/hot deck reset and setback control for the AHUs. Therefore, the AHU serving this area will cycle in the event that the temperature rises above or falls below the setback temperature in that area.

7. Concur. The economizer option in the EMS will be controlled by both outdoor dry-bulb and wet-bulb temperatures. This is typically referred to enthalpy control.

8. Concur. These local chiller functions will be tied into the central EMS.

9. Concur. Because the units currently have their thermostats controlling the cooling and heating coils, and because it is not feasible and economical to add economizer control to these AHUs; they will remain as they currently operate.

10. Concur. Chiller sizes will be corrected. A booster fan will be added to the proposed propane boiler where flue stack temperatures are much lower than a diesel fired boiler.

11. Concur. In using the melded electrical rate, an additional 180-ton back up chiller can be installed. Increasing the temperature drop across the coils, significantly reduces the capacity through the system, thus a smaller pump.

12. Concur. In using the melded electrical rate, an additional back up chiller can be installed.

13. Concur. Propane boilers will be proposed. We will recommend replacing the two boilers but not the heat exchanger.

H. **Margaret Danao, Aerotherm, 01 Mar 96:**

1. Exception (This comment refers to ECO F instead of ECO H). We do not recommend adding heat recovery bundles to chillers in this size range. Also, facility maintenance personnel would rather see isolated heating and chilled water systems. Moreover, In using the melded electrical rate, an additional back up chiller can be installed.

2. Exception. Refer to response to comment # 1.

3. Concur. Recommendations for grouping ECO's will be provided in the final report, but this does seem to be a logical solution.

4. Concur.

5. This response refers to the comment for ECO H. Concur. Once the ECO C has been implemented, the heating load for Test Cell # 1 will significantly reduce. However, we will recommend two new boilers approximately the same size as the existing in lieu of possible future expansion.

I. **Jim Rosser, Aerotherm, 01 Mar 96:**

1. Concur. The payback *is* based on a 10-year outlook.

2. Concur.

3. Concur.

4. Concur.

5. Concur.

6. Concur.

7. Concur.

8. Exception. Good idea, but outside project Scope of Work.

9. Exception. The ECO already pays off even with adding an additional back up boiler. Thus associating a cost for facility downtime would not only be hard to quantify for an energy study but also would not have an additional impact on whether or not the ECO pays back or not.

10. Exception. Refer to the response to comment # 9

11. Exception. Refer to the response to comment # 9.

12. Exception. Refer to Figure 3, Page 8 for diesel fuel documentation of the buildings within the Scope of Work.

END OF REVIEW COMMENT ANNOTATIONS

US ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

## FACSIMILE TRANSMITTAL HEADER SHEET

FROM: NOAH BOOKER, JR. CESWF-ED-MR (817) 334-2763
CESWF-ED-M FAX (817) 334-3348

TO: MR. C.A. PIEPER HUITT-ZOLLARS (817) 335-3000
FAX (303) 335-1025

PLEASE NOTIFY ABOVE RECIPIENT UPON RECEIPT

SUBJECT: LIMITED ENERGY STUDY, EEAP - HELSTF, WSMR, NM

THIS SHEET + 10 PAGES DATE: 07 Feb 1996

COMMENTS: ATTACHED ARE ALL COMMENTS RECEIVED TO DATE. ANY ADDITIONAL COMMENTS WILL BE PROVIDED UPON RECEIPT.

| DATE: 07 February 1996 | Page 1 of 2 |
|---|---|

**MOBILE DISTRICT PROJECT REVIEW COMMENTS:**

FROM: Anthony W. Battaglia, CESAM-EN-DM
Phone: (334) 690-2618 FAX: (334) 690-2424

TO: Noah Booker, CESWF-ED-MR
USAED, Fort Worth, Texas
PROJECT/FY: FY95 Limited Energy Study, HELSTF
LOCATION: White Sands Missile Range, New Mexico
TYPE REVIEW: Interim Submittal

| | Page/Par | COMMENT | Response to Comment |
|---|---|---|---|
| 1. | General | Overall, this report is thorough and well-documented. Especially commendable is the approach taken to integrate the savings calculations for the various ECOs so that the total presents a true picture of the potential savings for the site. | |
| 2. | Pg 3 | In the description of Test Cell 1, there was no mention of certain spaces having to be maintained at positive pressure with respect to the outdoors or to adjacent spaces; nor was there any mention of certain spaces having to be maintained at a constant temperature to maintain calibration of critical optical paths. This could have an impact on some ECOs. Please discuss. | |
| 3. | Pg 8 | Two questions regarding profiles of electrical and Diesel fuel usage:<br>a. How do the computer-modeled energy usages compare to the metered usages?<br>b. The HELSTF is the primary customer on a feeder that serves a certain portion of the range; ie, there are some other customers. How has this been taken into account? Can this explain the unusual profiles? | |
| 4. | Pg 9 | The scope of work, Tab 4, page D-9, par 4, states that the HELSTF reimburses White Sands Missile Range for electrical energy at a melded rate of $.083/ Kwhr. It was agreed that this would be the rate to use in savings calculations. The AE has separated demand and energy charges, which is normally the preferred approach. I would not insist on redoing the calculations; but I think this point should be discussed in the review meeting. | |
| 5. | Pg B-65 | Estimate for occupancy sensors: The time allowed for installation of occupancy sensors appears to be adequate; but the description of the ECO stated that some recirculting would be necessary. A line item should be added for this effort. | |
| 6. | Pg B-70 | Par 6: Which building does this apply to? | |
| 7. | Pg B-75 | There are a total of 7 OA temperature and humidity sensors shown for TC-1. This data should already be available from AHU S-1 in the LSTC building. Or perhaps one set in each building would be sufficent. | |
| 8. | Pg B-112 & Pg B-120 | Two comments on the estimates for chiller retrofits:<br>a. Please separate costs for demolition and new construction.<br>b. Wouldn't there be a cost for pumping down and disposing of R-11 from the existing chillers? | |
| 9. | Pg B-113 & Pg B-121 | Item 3.,B.,1. of the LCCA Summary Sheet: Suggest changing the identification of the savings from "Refrigerant" to "Existing Chiller Retrofit" or something along those lines. | |
| 10. | Pg B-115 | Regarding the existing cooling tower: Par 3 on page 4 states that this cooling tower appears to need a major overhaul. Should that be addressed in this ECO? | |

| DATE: 07 February 1996 | Page 2 of 2 |
|---|---|

| | |
|---|---|
| LE DISTRICT PROJECT REVIEW COMMENTS: | FROM: Anthony W. Battaglia, CESAM-EN-DM |
| To: Noah Booker, CESWF-ED-MR | Phone: (334) 690-2618 FAX: (334) 690-2424 |
| USAED, Fort Worth, Texas | |

PROJECT/FY: FY95 Limited Energy Study, HELSTF

LOCATION: White Sands Missile Range, New Mexico

TYPE REVIEW: Interim Submittal

| NO. | Page/Par | COMMENT | Response to Comment |
|---|---|---|---|
| 11. | Pg B-123 | Par D-2; Consider this: Due to their age, the existing boilers have required some extraordinary maintenance in the past few years, and it is reasonable to expect that they would require more-than-normal maintenance for the next year or so (until they fail). So some maintenance savings could be predicted for the first two or three years of the new boiler's life. | |
| 12. | General | Some minor typos, misspellings, and grammatical errors were found. Please proofread carefully and correct. | |

Bennett, Allen

From: Steve Ward
To: Bennett, Allen
Subject: Draft comments on HELSFT
Date: Thursday, February 01, 1996 1:03PM

Subject: Time: 12:48 PM
OFFICE MEMO Draft comments on HELSFT Date: 2/1/96

Allen,
Below is a draft copy of my comments. I will bring over the a final version after you find out one way or another that volume 2 is available for review. If you have any comments on my comments let me know.

Note: I did not have a copy of volume II, so some of these comments maybe answered in that volume.

1. In the ECO-A table of proposed changes, the following comments list some examples of the rooms that should not have lights left on 24 hours a day.

a. Page B-3, Mechanical Room, battery room, janitor closet. Savings of 13,189 KWH

b. Page B-4, Magnetic Tape Storage. Savings of 2,579 KWH

c. Page B-5, Storage B-19, B-20, B-21; Air Duct B-30; break room, and kitchen. Savings of 10,707 KWH.

d. Page B-6, Conference room, electrical equipment B-24, fall out shelter supply B-22, and equipment B-28. Savings of 9,057 KWH.

e. Page B-7, Boiler room, storage B-25, storage B-25A, basement mezzanine, closet 105. Savings of 8,328 KWH.

f. Page B-8, Janitor closet. Savings of 397 KWH.

These rooms have local switches, eliminating the cost of saving energy. The above savings was calculated by reducing the "on" time to 9 hrs., 5 days/ week. Some of these rooms are unoccupied even less and could be kept off most of the time. I assume the operational hours of the lights are the current hours. A comparison with these new "on" hours and installing the motion detectors should be computed, assuming that the motion detectors will be better at turning off the lights than the employees.

2. Recommend a table similar to the ones on B-29 and B-31 showing only the total annual energy usage for all the items for each ECO. This would allow a one or two page "quick look" which ECO offers the most savings and in what areas.

3. Page B-33, The "Other" costs need to be explained (e.g., a note referencing page B-1, section A). Also explain how the number was calculated.

4. Page B-66, The "Other" costs need to be explained (e.g., a note

eferencing page B-34, section A). Also explain how the number was calculated.

5. Page B-63, The "Other" costs need to be explained (e.g., a note referencing page B-57, section A). Also explain how the number was calculated.

6. Page B-113, The "Other" costs need to be explained (e.g., a note referencing page B-106, section A). Also explain how the number was calculated.

7. Page B-129, The "Other" costs need to be explained (e.g., a note referencing page B-122, section A). Also explain how the number was calculated.

SW

----- Message Header Follows -----
Received: from nebula.tbe.com by ssdch-usassdc.army.mil
 (PostalUnion/SMTP(tm) v2.1.8d for Windows NT(tm))
 id AA-1996Feb01.130317.1090.183408; Thu, 01 Feb 1996 13:03:17 -0600
Received: by nebula.tbe.com (5.65/DEC-Ultrix/4.3)
 id AA28085; Thu, 1 Feb 1996 13:06:21 -0600
Message-Id: <n1382942570.62002@pobox>
Date: 1 Feb 1996 13:02:14 -0600
From: "Steve Ward" <steve_ward@pobox.tbe.com>
Subject: Draft comments on HELSFT
To: "Allen Bennett" <BennettA@ssdch-usassdc.army.mil>
X-Mailer: Mail*Link SMTP-QM 3.0.3 b1 d5

EL-PE MCMD NM FEB 07 '96 01:14PM CESWF ED M (505-678-2752) FEB 01 '96 P.6/11

ENGINEERING REVIEW COMMENT | WHITE SANDS MISSILE RANGE | SHEET 1 OF 5

PROJECT TITLE Energy Study (EEAP) at HELSTF FACILITY

ITEM NO.

BY— J.T. Delgado

DATE— 31 Jan 96

LEGEND
A. CONCUR
D. DO NOT CONCUR
E. EXCEPTION SEE COMMENT
X. DELETE COMMENT

☐ PRELIM ☐ FINAL ☒ Interim | ☐ CIVIL ☐ ARCH. ☐ STRUCT. | ☐ MECH. ☐ ELECT. ☐ SPECS. | ☐ EST. ☒ Energy ☒ Utilities

| DWG. OR PAGE NO. | CMT. NO. | COMMENTS | ACTION WS |
|---|---|---|---|
| | | VOLUME I | |
| ii | 1 | Remove "FACILITY" when referring to HELSTF since HELSTF is the High Energy Laser Systems Test Facility. | |
| 4 | 2 | Paragraph 1. LSTC - Statement made in 8th sentence, "The replacement of fluorescent lamps should bring the lighting levels - - - since the replacement energy efficient lamps have a lower lumen output - - - - lamps." conflicts with statement made on Page B-1, paragraph C. 2nd sentence, "The newer technology T8 lamps can produce an equivalent or higher lumen output, with a lower power input." From an energy standpoint, the T8's will reduce energy usage, but we do not want to lower lumens if possible because it has a negative quality of life perception by the occupants. | |
| 8 | 3 | Request Base Year Utilities Data for electricity, Fig 3 & 4, be replaced . . . | |

| ENGINEERING REVIEW COMMENT | WHITE SANDS MISSILE RANGE | SHEET 2 OF 5 |
|---|---|---|

PROJECT TITLE (See Sheet 1)

ITEM NO.

BY— J. T. Delgado

DATE— 31 Jan 96

LEGEND
A. CONCUR
D. DO NOT CONC
E. EXCEPTION SEE COMMENT
X. DELETE COMME

☐ PRELIM ☐ FINAL ☐ | ☐ CIVIL ☐ ARCH. ☐ STRUCT. | ☐ MECH. ☐ ELECT. ☐ SPECS. | ☐ EST. ☐ ☐

| DWG. OR PAGE NO. | CMT. NO. | COMMENTS | ACTION WS |
|---|---|---|---|
| 8 | 3 | (continued): with enclosed data, Sheet 5 | |
| 12 | 4 | It is not apparent that the affect of installing energy efficient lighting in ECO-A affects energy savings in ECO-B. Was this considered? | |
| A-1 | 5 | Change Fuel Charge to $0.01306 per KWH. Comment: This will have an impact on all electric "Avoided Cost of Energy (CE)" calculation and may cause marginal projects to not qualify for special energy program funding. | |
| A-7 | 6 | Change Propane Fuel Rate to $0.676 per gallon. | |
| A-7 | 7 | In using Life Cycle Cost Analysis calculations, the MMBTU conversion factors for Diesel Fuel & Propane are: Diesel Fuel: 5.825 per MMBTU Propane Fuel: 9.55 per MMBTU | |

| ENGINEERING REVIEW COMMENT | WHITE SANDS MISSILE RANGE | SHEET 3 OF 5 |
|---|---|---|

PROJECT TITLE (See Sheet 1)

ITEM NO.

BY— J.T. Delgado

DATE— 31 Jan 96

☐ PRELIM ☐ FINAL ☐ | ☐ CIVIL ☐ ARCH. ☐ STRUCT. | ☐ MECH. ☐ ELECT. ☐ SPECS. | ☐ EST. ☐ ☐

LEGEND: A. CONCUR D. DO NOT CONCU E. EXCEPTION SEE COMMENT X. DELETE COMMEN

| DWG. OR PAGE NO. | CMT. NO. | COMMENTS | ACTION BY WS | | SW |
|---|---|---|---|---|---|
| B-1 | 8 | See comment #2 on C, second sentence. | | | |
| B-10 | 9 | Since volume/chiller control is inherent in a VAV system and therefore changes the cooling load on the chillers, wouldn't a screw-type chiller be more efficient on partial load operations in lieu of installing a smaller chiller? | | | |
| B-115 | 10 | If a centrifugal chiller has a rating of 0.59 KW/ton, it should be installed. I do not agree that the existing (second chiller) should remain as a backup because: 1) it uses R-11 refrigerant and will need replacing, and, 2) chilled water reduced flow for new centrifugal chiller will of operational efficiency of this standby chiller. | | | |
| | | VOLUME II | | | |
| Appendix 6 | 11 | There appears to be a conflict with electrical consumption appearing in Appendix 6 which affects Appendix 7 | | | |

| ENGINEERING REVIEW COMMENT | WHITE SANDS MISSILE RANGE | SHEET 4 OF 5 |
|---|---|---|

PROJECT TITLE (See Sheet 1)

ITEM NO.

BY— J.T. Delgado

DATE— 31 Jan 96

☐ PRELIM ☐ FINAL ☐

☐ CIVIL ☐ ARCH. ☐ STRUCT.

☐ MECH. ☐ ELECT. ☐ SPECS.

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E. EXCEPTION SEE COMMENT
X. DELETE COMMEN

| DWG.OR PAGE NO. | CMT. NO. | COMMENTS | ACTION BY WS | | SW |
|---|---|---|---|---|---|
| Appendix 6&7 | 11 | (continued): Trace 600 analysis. Please compare Appendix 6 electric energy usage to metered data referred to at Comment #5. | | | |
| ECO's | 12 | Generally, due to Fuel Charge change from $0.01753/KWH to $0.01306/KWH, all Life Cycle Cost Analyses for ECO's A through H need to reflect this change. | | | |
| | 13 | Excellent study. | | | |

ACTUAL CHARGES TO CSSD FOR FY 95 ELECTRICAL CONSUMPTION
(Based on adjustments required to correct for periods when switching was required on Post Area Feeder 5)

| | DOME BASE KWH* | TOTAL ADJUSTED KWH | TOTAL ADJUSTED CHARGES |
|---|---|---|---|
| OCT 94 | 980,000 | 1,390,271 | $105,244 |
| NOV | 798,000 | 1,076,052 | $81,457 |
| DEC * | 756,000 | 892,924 | $67,594 |
| JAN 95* | 868,000 | 986,335 | $80,978 |
| FEB | 868,000 | 1,211,150 | $99,435 |
| MAR | 896,000 | 1,124,722 | $92,340 |
| APR | 812,000 | 1,109,034 | $91,052 |
| MAY | 826,000 | 1,240,567 | $101,851 |
| JUN | 854,000 | 1,028,964 | $84,478 |
| JUL | 952,000 | 1,119,594 | $91,919 |
| AUG | 938,000 | 1,077,754 | $88,484 |
| SEP | 966,000 | 1,023,260 | $84,010 |
| | 10,514,000 | 13,280,627 | $1,068,842 |

*NOTES:

1. The DOME BASE (LSTC) represents almost 80% of the total CSSD consumption. KWH cited are from meter readings from the meter in the basement of the DOME BASE.

2. The DEC 94 and JAN 95 figures may be low. Estimates were made based on past history since one of the large uprange users was running on generator power from 11 Nov 94 through Jan 17 95.

Prepared by:
Sharon Shaddock
DPW-PE
01 Feb 96
678-5401

Wednesday January 24, 1996

ENERGY STUDY (EEAP) AT HELSTF FACILITY

File: i:\culpep_g\ESEEAPHF.DBF

| Num | Name | Office | Page/Sheet | Discipline | Rm/Detail |
|---|---|---|---|---|---|
| 1 | CULPEPPER-GEORGE | CESWFED-TM | VOL1-A-1&2 | MEC | A-1&2 |

AVOIDED COST IS CALCULATED USING AN ENERGY CHARGE OF $0.008/KWH YET THE RATE SCHEDULE ON THE NEXT PAGE SHOWS A RATE OF $0.004/KWH. PLEASE EXPLAIN WHY THIS APPEARENT ERROR EXISTS.

| Num | Name | Office | Page/Sheet | Discipline | Rm/Detail |
|---|---|---|---|---|---|
| 2 | CULPEPPER-GEORGE | CESWFED-TM | VOL1-A-B-33 | MEC | ALL ECO'S |

THE FOLLOWING DISCOUNT FACTORS WERE USED FOR ENERGY ALL CONSERVATION OPPORTUNITIES. 15.08,18.57,21.02,18.58,16.83,17.38,14.88,AND 14.88 APPEAR IN ALL CASES. PLEASE EXPLAIN WHY THEY DO NOT MATCH THE 1994 PUBLICATION AND WHY THE REGION WAS NOT WEST (REGION 4).

| Num | Name | Office | Page/Sheet | Discipline | Rm/Detail |
|---|---|---|---|---|---|
| 3 | CULPEPPER-GEORGE | CESWFED-TM | EOC-C | MEC | B-74 & 75 |

EOC-C SHOWS AN INSTALLED COST OF $393,914 (INCLUDING DESIGN). IT IS MY OPINION THAT THIS COST WILL BE IN EXCESS OF $432,000 BASED ON THE NUMBER OF POINTS THAT YOU RECOMMEND AND TESTING (FACTORY & FIELD VERIFICATION) THAT ARE OUR STANDARD REQUIREMENTS.

| Num | Name | Office | Page/Sheet | Discipline | Rm/Detail |
|---|---|---|---|---|---|
| 4 | CULPEPPER-GEORGE | CESWFED-TM | EOC-ALL | MEC | ALL |

RANKING EOC'S BY SIMPLE PAYBACK AND SIR PRODUCES THE SAME RANKING. IS THIS NORMAL AND CAN IS THIS YOUR RECOMMENDATION OF THE ORDER IN WHICH THEY SHOULD BE DONE. PLEASE COMMENT/PRODUCE A RECOMMENDATION.

| Num | Name | Office | Page/Sheet | Discipline | Rm/Detail |
|---|---|---|---|---|---|
| 5 | CULPEPPER-GEORGE | CESWFED-TM | EOC-ALL | MEC | RECOMMEND |

MAKE A RECOMMENDATION ON HOW THE EOC'S SHOULD BE ACCOMPLISHED AND SUPPORT YOUR RECOMMENDATION.

HIGH ENERGY LASER SYSTEM TEST FACILITY

| | |
|---|---|
| To: | Mr. Noah Booker |
| Company: | US Army Corps of Engineers, FW Dist. |
| Phone: | 817-334-2763 |
| Fax: | -3348 |
| From: | Larry I Brooks, P.E. |
| Company: | HELSTF White Sands Missile Range NM |
| Phone: | DSN 349-5486 |
| Fax: | -5068 |
| Date: | 14 February 1996 |
| Pages including this cover page: | 8 |

COMMENTS:

Noah, The attached comments are from Aerotherm, the HELSTF site contractor. Additional comments are expected and will be forwarded as received. The review conference is confirmed for 6 March, 1996 at the HELSTF. Please foreword a security access request for the attendees, on your letterhead. Information necessary is the following: Name, Social Security #, Date and Place of Birth, and any security clearances held. Thanks

Sincerely,

Larry Brooks, P.E.
General Engineer

## Interoffice Communication

95-MD03
9 February 1996

**TO:** Larry Brooks

**FROM:** Margaret Danao – AEROTHERM

**SUBJECT:** Comments on Interim Report for the Energy Audit

In response to your request to John Skipper for comments on the "The Energy Study (EEAP) at HELSTF Facility, White Sands Missile Range, New Mexico, Interim Report, Volume 1", the following is provided.

SUMMARY
The Energy Audit appears to be quite thorough in extent and content. The options are ranked according to the Savings to Investment Ratio (S.I.R.) potential. From an operational viewpoint at HELSTF, the Chiller Retrofit at the LSTC building and the Chiller Retrofit at the Test Cell 2 Building should be a priority, because R-11 is no longer being made. For the LSTC Chiller retrofit, a 59-ton backup chiller will be insufficient to support a test if the 175-ton chiller is down. The VAV Controls retrofit should be combined with the Energy Management System for HVAC Controls because each will be an integral part of the other. The Boiler retrofit at Test Cell 2 should be designed in conjunction with the Test Cell 2 chiller retrofit because they are both part of the same HVAC system. The capacity of the recommended boiler seems insufficient.

In regard to the electrical demand charges, in the detailed scope of work, p.D-9, it is stated that "SSDC reimburses WSMR for electrical energy used at a melded rate of \$.083/Kwh. This is not addressed in the Avoided Cost calculations. The Demand Savings will only be reflected in the HELSTF bill, if that is negotiated in the Memorandum of Understanding between WSMR and SSDC.

ECO's and SPECIFIC COMMENTS
ECO-A, Lighting Fixture Upgrade - Higher wattage lamps generate more heat which is an asset in the winter and a detriment in the summer. This will affect the HVAC usage.

ECO-B, Occupancy Sensors For Lighting Controls - No comment

ECO-C, Energy Management System for HVAC Controls - This should be done in conjunction with ECO-D, the VAV Controls Retrofit because the EMS system will be an integral part of the VAV Controls Retrofit.

ECO-D, VAV Controls Retrofit - See comment for ECO-C.

ECO- E, High Efficiency Motor Retrofit - No comment

ECO- F, Chiller Retrofit at LSTC Building: This is a very important ECO because of the fact that R-11 is no longer produced. The two existing chillers are 175-ton (not 154-ton units). The capability to cycle between a 59-ton unit and a 175-ton unit for low cycle and high cycle usage, is a good idea from an efficiency standpoint, however it is not good from an operational standpoint. If the 175-ton chiller is down, then the 59-ton chiller would not be sufficient to allow the computer systems in the LSTC to operate, even in the winter. HELSTF would not be able to operate computer systems, nor support a test if the 175-ton chiller was down. (A 59-ton chiller could be installed in conjunction with the two 175-ton chillers, because their are 3 pads available.)

Both chillers should be replaced with 175-ton units. As a temporary measure, one of the existing chillers could be used as a backup unit, with a reserve margin of 2400 lbs. of refrigerant on site. A device called a "Vent-Guard II" should also be installed on this chiller if it is used as the backup chiller. (The Vent-Guard is a safety-relief valve which is located between the bursting disk and the vent piping.) It provides protection in the event of a disk rupture. The chiller which is removed should be salvaged for parts. In regard to the installation of a boiler instead of a reheat unit, this will require maintaining the boiler and diesel boilers require alot of maintenance.

ECO-G, Chiller Retrofit at Test Cell 2 Building: This is a very important ECO because of the fact that R-11 is no longer produced. I agree with the statement by Huitt-Zollars, Inc. that the chillers are in average to poor condition. Both chillers should be replaced. As a temporary measure, one of the existing chillers could be used as a backup unit. If one of the existing chillers is used as a backup chiller, a reserve margin of R-11 refrigerant should be maintained on-site. Also, the Vent-Guard device should be installed on the chiller. The chiller which is removed should be salvaged for parts for the remaining chiller. I don't agree with the recommendation that one of the cooling tower cells be de-activated. Both cooling tower cells should be maintained and used alternately if only one cell is required.

ECO-H, Boiler Retrofit At Test Cell 2 Building: This project should be planned with ECO-G because the heating and cooling equipment is all inter-related. I agree that a backup boiler should be maintained. The reduction from 1104 MBH to 770 MBH is questionable because the capacity may be insufficient to maintain proper conditions in Test Cell 1.

Margaret Danao
Mechanical Engineer, Laser, Optics and Test Department

cc: J. Skipper

AEROTHERM - FAC. ENGR.

1. There is no reference to usage of diesel fuel for the PRS and Cleaning Facility. These areas are also users of diesel fuel. The PRS usage will vary depending on testing requirements.

2. It appears there are recommendations to shut down various systems during off hours (1600 hours- 0700 hours). There are still personnel(HELDAPS) in the LSTC during those hours, which would create problems. One such problem would be in reference to page B-68, paragraph number 6, the exhaust fan EF-2 being shut off.

# ENERGY STUDY COMMENTS

**SUBMITTED BY**
**FACILITIES SUPPORT GROUP**

1. • **PAGE 4, ITEM # 3** **February 5, 1996**

HEAT EXCHANGER REMOVAL WOULD BE GOOD, BUT WITHOUT THEM WE WOULD LOSE FREEZE PROTECTION. TO USE GLYCOL ON SECTIONAL BOILERS IS NOT A GOOD IDEA, THIS CAN CAUSE PROBLEMS WITH GASKETS FAILING AND SLUGGING IN THE BOILER. BOILER COULD NOT BE BLOWN DOWN TO REMOVE SLUDGE FROM THE SYSTEM, **DUE TO ENVIRONMENTAL CONSIDERATIONS AND COST OF REPLACEMENT OF GLYCOL.**

2. • **PAGE B-69, ITEM #6 (EF-2?)**

PUMP P-5, HOT WATER PUMP--- THIS IS THE ONLY HOT WATER SOURCE FOR THE BUILDING'S TEMPERATURE CONTROL. SHUTTING DOWN THIS UNIT WILL AFFECT THE OPERATION OF THE CHILLERS. ALL THE HEAT WILL BE TRANSFERRED AND REJECTED AT THE COOLING TOWER RESULTING IN WASTED ENERGY.

3. • **PAGE B-68, ITEM #7**

CONTROLS OPERATE AS STATED IN THIS SECTION. CHW & HW VALVES ARE PNEUMATICALLY CONTROLLED. EH-51 & EH-53 ARE CONTROLLED THE SAME WAY AND DO SHUT OFF WHEN HUMIDITY LEVELS ARE REACHED.

THE REAL PROBLEMS COME ON HIGH HUMIDITY DAYS WHEN AH'S CAN NOT DEHUMIDIFY THE AREA.

THERE ARE NO EMS CONTROLS.

4. • **PAGE B-68, ITEM # 1**

SPECIAL CONSIDERATION WILL HAVE TO BE GIVEN WHEN REDUCING THE CFM LEVEL TO AHU-S1. EVERYONE SHOULD BE AWARE THAT THERE ARE THREE (3) CHILLERS LOCATED IN THE BASEMENT OF THE LSTC. EACH UNIT, IF THE REFRIGERANT CHARGES ARE AT THEIR PROPER LEVEL, CONTAIN 800 lbs FOR A TOTAL OF 2400 lbs OF OXYGEN DEPLETION CHEMICAL. THERE ARE NO OXYGEN DEPLETION OR REFRIGERANT DETECTION ALARMS IN THE AREA(SAFETY ).

THIS COMBINED WITH THE PROBLEMS ELUDED TO IN ITEM # 6 (BUILDING EXHAUST FAN) WILL HAVE TO BE DESIGNED TO WORK IN UNISON.

5. • **PAGE B-69, ITEM # 2**

SHUTTING DOWN AHU'S AS STATED, AND STILL BE ABLE TO MAINTAIN TEMPERATURES ABOVE 80 DEGREES, WILL DRAMATICALLY AFFECT THE OPERATION OF THE CHILLER OPERATIONS WHERE THEY WILL SHUT DOWN ON A MECHANICAL FAILURE AND WILL HAVE TO BE MANUALLY RESET.

6. • **PAGE B-69, ITEM # 3**

MULTI-ZONE AHU-1 I BELIEVE IS THE AHU THAT GOES TO THE COMMO ROOM AND OFFICE AREAS IN THE BASEMENT. THE COMMO ROOM IS A HEAT GENERATION AREA AND NEEDS TO BE KEPT COOL FOR THE EQUIPMENT.

IT WILL NOT MATTER IF BRANCH REHEAT VALVES OPEN OR CLOSE BECAUSE THERE WILL BE NO HOT WATER FLOWING, AS STATED IN ITEM # 6 OF PAGE B-68

7. • **PAGE B-69, ITEM # 4**

LETS NOT FORGET THAT TC-1 IS A CRITICAL PART OF THIS TEST SITE, WE MUST MAINTAIN TEMPERATURES AND HUMIDITIES AS REQUIRED, UNTIL THOSE REQUIREMENTS ARE CHANGED.

ALL AHU'S SHOULD MONITOR BOTH WET AND DRY BULB TEMPERATURES SO THAT THE OUTSIDE AIR DAMPERS WILL CLOSE ON THOSE DAYS WHEN WE HAVE HIGH TEMPERATURES AND HUMIDITIES. ( WE NEED TO PLAN FOR THE WORSE CASE SCENARIO)

8. • **PAGE B-70, ITEM # 5**

EXISTING CHILLER CONTROLS ALREADY PERFORM A LOT OF THESE FUNCTIONS. COOLER (EVAPORATOR) AND CONDENSER PRESSURES AND WATER TEMPERATURES ARE CONTROLLED BY TEMPERATURE AND PRESSURE SENSORS ON THE UNIT. THERE ARE NO EMS' ON THE UNITS.

9. • **PAGE B-70, ITEM # 7**

THERE IS NOTHING MENTIONED OF AHU-1, AH-54 AND AH-55 WHICH HAVE A GREAT EFFECT UPON AH-53 WHICH DUMPS INTO THE OPTIC ROOM.. AH-51 FOR THE DEVICE ROOM HAS ITS OWN HUMIDIFIER, ESH-51. AH-52 FOR THE BTA COMPUTER ROOM IN THE ETA AREA, ALSO HAS IT'S OWN HUMIDIFIER, BUT IT HAS BEEN CANNIBALIZED OVER THE YEARS AND IS NOT OPERATIONAL.

ESH-53 HUMIDIFIES THE OPTIC ROOM, IT'S HUMIDITY IS FED THROUGH AH-53. THIS UNIT TAKES CARE OF HUMIDITY IN THE SAME AREA THAT AHU-1, AH-54 AND AH-55 SUPPLY CONTROLLED AIR TEMPERATURE TO, IN THE OPTICS ROOM.

10. • **PAGE B-106, ITEM # B**

LSTC CHILLER SIZES ARE 175 TONS EACH , NOT 154 TONS.

I DO NOT KNOW EXACTLY WHY THE BOILER IN THE LSTC FAILED, THAT WAS BEFORE MY TIME. BUT I TEND TO THINK THAT THE UNIT FAILED BECAUSE OF ITS PRESENT LOCATION. EVEN THOUGH THE UNIT IS EQUIPPED WITH A FLUE DISCHARGE FAN TO ASSIST IN DISCHARGING THE FLUE GASSES OUT OF THE UNIT AND BUILDING, THIS MAY HAVE BEEN THE MAJOR PROBLEM WITH THE UNIT. FLUE STACK TEMPERATURES COULD NOT BE MAINTAINED, SO THAT THE FLUE STACK COULD DRAW OUT THE GASSES AND THE COOLED FLUE GASSES WOULD THEN FALL BACK INTO THE BASEMENT AND THEREFORE INTO THE BUILDING.

IN INSTALLING NEW AND SMALLER UNITS IN THE SAME LOCATION, I BELIEVE THAT THE SAME PROBLEM COULD OCCUR, ESPECIALLY WITH A DIESEL BOILER WHERE STACK TEMPERATURES NEED TO BE HIGH, 400 DEG. F TO 600 DEG. F AVERAGE.

11. • **PAGE B-107, ITEM C**

THERE IS NO REDUNDANCY FOR THE 180 TON UNIT IF MAJOR MAINTENANCE HAS TO BE PERFORMED ON IT. CHANCES ARE THAT A 59 TON UNIT WILL NOT BE ABLE TO MAINTAIN THE LOADS DURING A WORSE CASE SCENARIO, ALTHOUGH THE CONCEPT IS GOOD.

REDUCING THE PUMP AND/OR MOTOR SIZE FOR THE CHW IS A GOOD IDEA, ALL AH'S ARE LOCATED IN THE BASEMENT, PUTTING MINIMAL HEAD PRESSURE ON THE PUMP. REDUCING THE MOTOR SIZE ON THE HOT WATER PUMP IS QUESTIONABLE, THE LOCATION OF THE HEAT COILS ARE EXTREMELY HIGH PUTTING A LOT ON HEAD PRESSURE ON THE PUMP, WHICH MIGHT CAUSE PUMP FAILURE AND UNEVEN DISTRIBUTION OF HOT WATER TO THE HEATING COILS.

12. • **PAGE B-115--B-115 , ITEM C**

BECAUSE WE OPERATE WITH ONE CHILLER DURING THE MAJORITY OF THE YEAR, IT IS STILL IMPORTANT THAT WE REPLACE BOTH UNITS. THE COST AND AVAILABILITY OF R-11 IN THE FUTURE CAN AND WILL BE EXTREMELY HIGH, NOT TO MENTION THE POSSIBILITY OF EPA FINES FOR USING AN OUTLAWED REFRIGERANT AND PAYING THE COST OF DISPOSING OF THE UNIT AND IT'S REFRIGERANT IN THE FUTURE.

FUTURE EXPANSION TO THE SYSTEM SHOULD BE CONSIDERED. THERE HAVE BEEN MANY ADDITIONS , IN THE PAST YEARS.

IT IS BEST TO DO AWAY WITH CHILLER CONDENSER WATER PUMPS P-60 & P-61 AND INSTALL NOT ONE BUT TWO COOLING TOWER PUMPS AS STATED IN THIS SECTION. TIEING THESE PUMPS DIRECTLY INTO THE CONDENSER OF EACH CHILLER.

NOTE: GPM MIN. FLOW THROUGH THE CONDENSERS IS VERY CRITICAL FOR PROPER UNIT OPERATION.

13. • **PAGE B-122---B-123.**

LPG BOILERS SHOULD BE CONSIDERED, IT IS A CLEANER BURNING AND MORE EFFICIENT FUEL THAN DIESEL. BOTH UNITS SHOULD BE REPLACED EVEN THOUGH ONE IS CONSIDERED A BACKUP. BOTH UNITS ARE OPERATION YEAR ROUND, ONE AT A LOWER TEMPERATURE THAN THE OTHER. THIS HAS REDUCED THE NUMBER OF CALL OUTS WE HAVE EXPERIENCED WHEN ONLY ONE IS ON THE LINE

THE CLEAN AIR ACT MAY HAVE MORE STRINGENT REQUIREMENTS, IN THE FUTURE, ON DIESEL BURNERS.

REDUCING THE SIZE OF THE UNITS WILL RESTRICT US FROM FURTHER FUTURE EXPANSION AND WILL CAUSE MAJOR TROUBLE IN MAINTAINING TEMPERATURES IN TC-1. IN THE WINTER BOTH UNITS ARE NEEDED TO MAINTAIN THE REQUIRED TEMPERATURES.

PLUMBING IN HOT WATER DIRECTLY TO THE SYSTEM AND REMOVING THE HEAT EXCHANGER IS A GOOD IDEA. BUT THE DISTANCE AND THE EXPOSURE TO THE OUTSIDE CLIMATE WILL HAVE TO BE CONSIDERED. HEAT EXCHANGERS ARE NOW BEING USED SO THAT WE CAN HAVE TWO SYSTEMS, (1) A BOILER LOOP SO THAT EACH UNIT CAN BE BLOWN DOWN AND RID THE SYSTEM OF ALL SOLIDS. (2) A HOT WATER LOOP THAT GOES TO TC-1 AND RETURNS BACK TO TC-2. THIS SYSTEM BEING A CLOSED LOOP CAN BE TREATED WITH RUST INHIBITORS AND ETHYLENE GLYCOL FOR FREEZE PROTECTION.

Interoffice Communication

96-MD04
1 March 1996

**TO:** Larry Brooks

**FROM:** Margaret Danao

**SUBJECT: Energy Study (EEAP) at HELSTF Facility, Interim Report**

With the extra time to review the energy study, John Skipper requested that I provide additional comments. If you have any questions, please call me.

## SUMMARY

As I mentioned in my first set of comments, the Energy Audit is quite thorough in extent and content. I commend Huitt-Zollars Inc. (HZ) on the excellent job that they did in performing the study. I agree with most of the ECOs and I propose that a few of the ECOs be changed. From an operational and maintenance viewpoint, I recommend that the LSTC chiller replacement (ECO-H) and TC2 chiller replacement (ECO-G) be done first. The units are old, they use R-11 refrigerant which is no longer being produced due to Federal Law, and a chiller failure could adversely impact a HELSTF test.

## RECOMMENDATIONS

1. For the LSTC chiller replacement (ECO-H), install two new 180 ton chillers with heat recovery instead of the boiler.

2. For the TC-2 Chiller Replacement (ECO-G), install two new 180 ton chillers with heat recovery instead of doing the Test Cell 2 Boiler Replacement (ECO-H).

3. Design and install the the Energy Management System for HVAC controls (ECO- C) be done at the same time as the VAV Controls Retrofit (ECO-D) because they are inter-related. The HVAC design work overlaps and the installation work overlaps, therefore it is cost effective to do these projects at the same time.

4. I agree with the remainder of the ECOs and recommend that we pursue funding for the implementation of all the ECOs as soon as possible.

These recommendations are explained by section below.

## ECO- F, CHILLER RETROFIT AT LSTC BUILDING

"Remove the two (2) existing 154 ton, R-11 centrifugal chillers, CH-1 and 3 in the basement of the LSTC building. Replace chiller CH-1 with a new 59 ton, R-22 reciprocating chiller in the same location. Replace chiller CH-3 with a new 180 ton, R-123 centrifugal chiller in the same location." (p. B-106, Volume I)

1. CH-1 is actually 177 tons and CH-3 is 156 tons per the Burns and Roe equipment schedule (Sequence No. 277, WSMR, HELSTF drawings by Burns and Roe, Inc.). I agree with the use of a R-123 centrifugal chillers because they are known as "positive pressure" units. In the case of system overpressurization they will draw air in, instead of releasing refrigerant. Because of the tendency to draw air in, less emission monitoring equipment is required than is required for other refrigerants.

2. I agree with HZ's findings that the chillers need to be replaced. The chillers are in poor condition and they use R-11 which is no longer being produced due to Federal regulations. Based on HZ's "ECO-F LSTC Building, Proposed Lighting and HVAC Systems Monthly Peak Demand" table (B-111, Volume I), and the chiller manufacturer's data (pp.s E-30 - E-37, Volume II), the minimum estimated cooling load is approximately 140 tons. According to HZ, the new estimated peak cooling demand is estimated to be 175 tons for the LSTC building (p. B-106, Discussion section). I recommend that HELSTF install two new 175 ton chillers (or 180 ton), so that we will always have a full capacity chiller available if the other is down due to maintenance or an equipment failure. The 59 ton chiller would not provide sufficient backup for the 180 ton chiller. I understand HZ's concern about one of the chillers operating on a low-load condition because it is energy inefficient. An alternative which HZ could investigate is the use of a 59 ton chiller, and a 120 ton chiller to provide the 180 ton coverage required.

3. I recommend that the chillers have the heat recovery units attached to them and that the boiler be eliminated. HZ said that "Due to smaller size chillers, a heat recovery package could make them inefficient. Therefore, a new fully modulating, package hot water boiler will be installed to furnish the supplementary heating needs." (Volume I, p. B-107). One chiller manufacturer provides a heat recovery package for centrifugal chillers 130 tons or larger. Heat recovery can be added to a chiller for approximately $10,000 which is comparable with the cost of a boiler.

4. As a temporary measure, CH-1 could be used as a back-up chiller. This would work provided that an on-site refrigerant reserve margin is maintained, CH-3 is salvaged for parts, and a refrigerant-containment device is installed. York, the chiller manufacturer, sells a refrigerant-containment device called a "Vent-Guard II Relief Valve and Rupture Disk". The Vent-Guard device is permanently installed on the chiller vent line and replaces the original carbon bursting disk. The bursting disk will rupture if the refrigerant system is over pressurized. At the same time, the safety relief valve will close when it senses the pressure drop and the refrigerant will be contained inside the unit instead of venting to the atmosphere. The bursting disk is made of non-fragmenting all-metal construction and therefore does not lose pieces when it bursts. It costs approximately $4000 per unit installed.

´3

## ECO-G, CHILLER RETROFIT AT TC2 BUILDING

"Remove the existing 175-ton, R-11 centrifugal chiller (CH-51) and its controls in Building TC-2 and replace it with one (1) 180 ton, R-123 centrifugal chiller (minimum full load KW/ton = 0.59). Reconnect the existing piping to the new chiller at the existing chiller location. The second existing 175 ton chiller (CH-52) shall remain and used as a back-up chiller." (ECO-G, p. B-114).

1. I agree with the recommendation that CH-51 be replaced with a 180 ton, R-123 centrifugal chiller. I recommend that CH-52 also be replaced with a 180 ton, R-123 chiller and that it only be used as a back-up chiller as a temporary measure. If CH-52 is used as a back-up as a temporary measure, then R-11 refrigerant should be stock-piled, CH-51 should be salvaged for parts, and a Vent-Guard device should be attached (described in ECO-F).

2. I recommend that chillers with heat recovery units be used instead of replacing the boilers. This will eliminate the boilers and the diesel fuel system which will equal less maintenance costs for the system.

## ECO-H, BOILER RETROFIT AT TEST CELL 2 BUILDING

The more that I have reviewed the study, I recommend using heat recovery instead of boilers. In my first writeup, I mentioned that the size boiler which HZ chose seemed low. I was incorrect, with the difference in efficiencies between the old and new boiler, the same heat capacity would be available.

Margaret Danao

Margaret Danao
Mechanical Engineer, Laser, Optics and Test Department

cc: J. Skipper

March 1, 1996

To: Larry Brooks

From: Jim Rosser

Subject: Energy Study Review Comments Revision 1

The following comments are in response to the ENERGY STUDY at HELSTF FACILITY conducted by Huitt-Zollars, Inc.

General

1. Based on the guidelines for EPIC qualifying projects, all of the proposed ECOs at HELSTF qualify with SIRs greater than 1.25 and payouts less than 10 years. Although I questioned why these numbers were generated on the assumption of a 20 year life cycle, it is now understood that this is probably the required term for ECO economics. Based on the above criteria, it is recommended that these projects be implemented as soon as possible in order to maximize the benefits of the program..

2. From Aerotherm's perspective, as the facilities contractor and representative for HELSTF, these projects can also be justified with additional savings of approximately $154,600/year which is derived from the difference between the actual cost of electricity ($.0821/kwh per Contract Mod P00006) and the calculated average demand and energy charge ( $.041/kwh) used in the life cycle analysis.

   The following table summarizes the savings as determined by the Energy Study. The last column indicates the rank of these projects based on those savings.

2. (cont.)

| PROJECT | ECO | Study Est Savings $/year Dem | Energy | Total | Elec Reduced kwh/year | Avg Price* $/kwh | Rank |
|---|---|---|---|---|---|---|---|
| Lighting | A | 18393 | 15080 | 33473 | 590,612 | .057 | 3 |
| Sensors | B | 176 | 10876 | 11052 | 426,167 | .026 | 4 |
| EMS | C | 11074 | 33054 | 44128 | 1,294,598 | .031 | 1 |
| VAV | D | 2927 | 9507 | 12434 | 372,289 | .033 | 5 |
| Motors | E | 3685 | 2670 | 6355 | 104,492 | .061 | 7 |
| Lstc Chiller | F | 13207 | 17384 | 30591 | 681,044 | .045 | 2 |
| TC-2 Chiller | G | 7769 | 6762 | 14531 | 264,913 | .055 | 6 |
| TC-2 Boiler | H | 538 | 516 | 1054 | 20,148 | .052 | 8 |
| TOTALS | | 57769 | 95849 | 153618 | 3,754,263 | .041 | |
| Actual Savings | | | | 308,225 | 3,754,263 | .082** | |
| Add'l Savings | | | | 154,607 | | | |

* The average price of electricity was determined by adding the annual demand and energy savings divided by the kwh/year as calculated by the Trace 600 program which used EPEC rates for military facilities.

** The actual rate charged to the HELSTF site per Contract Mod P00006.

Based on the cost difference between the actual cost of electricity and the Energy Study calculations, an additional savings of approximately $154,600 could be realized at HELSTF if these projects were implemented. The total kwh savings of 3,754,263 represents a reduction of electrical energy by 36% at the HELSTF facilities. Calculations, using these savings and the installation costs generated by the study, reduce the overall average payout of the projects to approximately 3.64 years which is highly acceptable. The life cycle calculations indicated an average payout of 7.2 years. Therefore, based on this analysis, it is also recommended that these projects proceed as soon as possible.

These economics do not include downtime and costs associated with any possible mechanical failures and long term delivery of equipment which could greatly affect operations and testing at HELSTF. Key equipment, such as the LSTC and TC-1 chillers, should be evaluated on repair and /or replacement economics with energy savings being a bonus for payout. It is understood that another program, FEMP, might apply for this type of retrofit. Therefore, the HVAC equipment and any other critical systems should be evaluated for upgrades.

Specific Comments

ECO-A Electronics Ballasts

3. Labor costs seem low. Conversations with Ken Timblin suggest that 1.0 hours for changing out ballasts and lamps is more reasonable than the .5 hours used in the study. However, by doubling the labor costs due to doubling the time would only increase the overall project cost by 24% and should not affect the qualification of this ECO because the original payout is low compared to the ECO criteria and the savings per year is substantial. The project merits implementation, however, it should be completed with temproray personnel support because a group relamping program is not possible on the strength of 1 electrician and a helper whose main function is test support.

ECO-B Occupancy Sensors

4. Labor costs seem low, whereby, only 1 hour is estimated for each installation. If it takes 2 hours, the labor costs would double, however, this would only increase the overall project by 15%. Again, the payout is low compared to ECO criteria, the investment is reasonable, and the savings per year acceptable. It is also recommended that temporary personnel be utilized.

ECO-C Management System

5. Extremely high investment with high payout, would require detailed design and implementation schedule.

ECO-D VAV Controls

6. Would seem to go with EMS system for implementation.

ECO-E High Efficiency Motors

7. Current practice is to replace failed motors with high efficiency type. Mass replacement would require shutdown of facilities, therefore, a purchase program with replacement as necessary would be feasible. Savings are not very substantial.

8. Although, the Scope of Work did not require review of electrical savings from auxiliary equipment operating outside of the building HVAC systems, additional savings may be realized thru a program of performing precision alignments using laser equipment. Not only electrical savings, but savings from reduction of equipment failures due to misalignment and savings in labor and downtime, can be obtained through the purchase and use of a laser tool. The current methods utilized at the facility using dial and reverse dial indicators are time consuming and do not allow absolute precision alignments which could result in added energy consumption and premature failure of the equipment. Therefore, it is recommended that a survey of applicable site equipment be performed and analyzed by site personnel for possible savings. Information on the laser equipment is currently being requested from outside vendors.

ECO-F Chiller Retrofit at LSTC

9. Should be pursued on failure type analysis and economics whereby laser facility downtime would be the payback as well as the energy savings.

ECO-G Chiller Retrofit at TC-2

10. Same as above.

ECO-H Boiler Retrofit at TC-2

11. Same as above.

Added Notes

12. Per Mike Corbett, diesel fuel usage at the PRS from 1-13-95 thru 2-08-96 was 43,672 gallons consumed by the boiler. Other diesel usage should be documented for other areas.

HUITT-ZOLLARS

Huitt-Zollars, Inc. / Engineering / Architecture / 512 Main Street / Suite 1500 / Fort Worth, Texas 76102-3999 / Phone (817) 335-3000 / Fax (817) 335-1025

April 10, 1996

Mr. Noah Booker
ATTN: CESWF-ED-MR
US Army Corps of Engineers
P.O. Box 17300
Fort Worth, TX 76102-0300

**RE: LIMITED ENERGY STUDY , HELSTF, (EEAP)**
**WHITE SANDS MISSILE RANGE, NM**
**MARCH 27, 1996 "PRE-FINAL REPORT" NOTICE TO PROCEED ENDORSEMENT**
**HZ PROJECT NO. 03-0185.05**

Dear Mr. Booker:

Transmitted herewith is one copy of the endorsed Notice to Proceed for the Pre-Final Report phase of the project. Based on our receipt of the NTP on March 27, 1996, the Pre-Final Report is due on or before Monday, May 6, 1996.

If you have any questions or require further assistance on this subject, please let me know. Thanks!

Sincerely,

HUITT-ZOLLARS, INC.

Denney R. Howard

Denney R. Howard, P.E.
HZ Project Manager

DRH:ph

Enclosure

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DEPARTMENT OF THE ARMY
FORT WORTH DISTRICT, CORPS OF ENGINEERS
P. O. BOX 17300
FORT WORTH, TEXAS 76102-0300

REPLY TO ATTENTION OF:

March 22, 1996

RECEIVED
MAR 27 1996
HZ

A-E Management Branch
Engineering Division

Huitt - Zollars, Inc.
512 Main Street, Suite 1500
Fort Worth, TX 76102-3922

Gentlemen:

Reference:

a. Your Contract Number DACA63-94-D-0015, Indefinite Delivery Contract for Architect Engineer Services Primarily for Master Planning Type Projects Assigned to the Fort Worth District.

b. Delivery Order Number 0009, to provide A-E services for FY 96, Energy Study (EEAP), HELSTF Facility, White Sands Missile Range, New Mexico.

The Interim Submittal for the referenced project is approved subject to incorporating the comments provided at the Interim Submittal Review Conference held at White Sands Missile Range on March 6, 1996.

If you feel that any of the comments require effort on your part, which is outside the original scope of the referenced delivery order, please contact this office immediately. These comments will not be accomplished without prior approval from this office. Two copies of the comments, depicting your annotated response/action, should be returned to this office within seven calendar days after receipt of this letter. Your annotated response should also identify conflicts in review comments which must be resolved prior to the next submittal.

You are to proceed with the preparation and submittal of the Pre-Final Submittal per the referenced delivery order and are to incorporate all comments into this next submittal, except those comments described in the preceding paragraph.

In accordance with the Scope of Work for the referenced delivery order, the Pre-Final Submittal is due within 40 calendar days after receipt of this letter. Your transmittal letter of the Pre-Final Submittal must include a certification that the documents have been subjected to your own review and coordination procedure to ensure:

a. Completeness for each item to be studied

b. Elimination of conflicts, errors and omissions

c. The overall professional and technical accuracy of the study

Please complete the enclosed endorsement and return a copy to this office (ATTN: CESWF-ED-MR). Should there be any questions, please contact Mr. Noah Booker, Jr., Engineering Manager, at (817) 334-2763.

Sincerely,

Jerrell P. Freeman

Jerrell P. Freeman, P.E.
Contracting Officer's
Representative

Enclosure

ENDORSEMENT

Receipt of authorization to proceed with the Pre-Final Submittal for FY 96, Energy Study (EEAP), HELSTF Facility, White Sands Missile Range, New Mexico.

This document was received: Date 27 March 1996

By Denny R Howard

Title Project Manager

HUITT-ZOLLARS

Huitt-Zollars, Inc. / Engineering / Architecture / 512 Main Street / Suite 1500 / Fort Worth, Texas 76102-3999 / Phone (817) 335-3000 / Fax (817) 335-1025

May 21, 1996

Mr. Noah Booker
ATTN: CESWF-ED-MR
US Army Corps of Engineers
P.O. Box 17300
Fort Worth, TX 76102-0300

**RE: LIMITED ENERGY STUDY , HELSTF, (EEAP)
WHITE SANDS MISSILE RANGE, NM
ANNOTATIONS TO INTERIM REPORT COMMENTS
HZ PROJECT NO. 03-0185.05**

Dear Mr. Booker:

Upon reviewing the request for two boilers in ECO H from the interim review comments, preliminary calculations indicated the two boilers would pay back. After performing more complete calculations, we have determined that only one boiler would pay back in ECO H. The reason that only one boiler pays back is that although propane gas is actually less expensive per gallon than diesel, it also has only approximately 65% of the heat content of diesel. Therefore, the $/MMBTU for propane is actually more than the $/MMBTU for diesel. Moreover, in our response to Comment # 11 from Mr. Anthony Battalglia, we concurred with the statement to add a three year maintenance savings associated with replacing the boiler. Actually, the maintenance personnel at the facility informed us that there is no excess maintenance required for the existing boilers. Moreover, the 1996 Windows™ version of LCCID from the Blast Support Office only allows for a one-time or annual non-energy savings. In other words, there was no accurate way to incorporate a maintenance savings for the first three years of the life of the equipment. If you have any questions or require further assistance on this subject, please let me know.

Sincerely,

**HUITT-ZOLLARS, INC.**

Denney R Howard

Denney R. Howard, P.E.
HZ Project Manager

DRH:ph

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# HUITT-ZOLLARS

Huitt-Zollars, Inc. / Engineering / Architecture / 512 Main Street / Suite 1500 / Fort Worth, Texas 76102-3999 / Phone (817) 335-3000 / Fax (817) 335-1025

July 22, 1996

Mr. Noah Booker
ATTN: CESWF-ED-MR
US Army Corps of Engineers
P.O. Box 17300
Fort Worth, TX 76102-0300

**RE: LIMITED ENERGY STUDY , HELSTF, (EEAP)**
**WHITE SANDS MISSILE RANGE, NM**
**"FINAL REPORT" NOTICE TO PROCEED ENDORSEMENT**
**HZ PROJECT NO. 03-0185.05**

Dear Mr. Booker:

Transmitted herewith is one copy of the endorsed Notice to Proceed for the Final Report phase of the project. Based on our receipt of the NTP on July 15, 1996, the Final Report is due on or before Friday, August 23, 1996.

If you have any questions or require further assistance on this subject, please let me know. Thanks!

Sincerely,

**HUITT-ZOLLARS, INC.**

Denney R Howard

Denney R. Howard, P.E.
HZ Project Manager

DRH:ph

Enclosure

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RECEIVED
JUL 15 1996
HZ

July 12, 1996

A-E Management Branch
Engineering Division

Huitt - Zollars, Inc.
512 Main Street, Suite 1500
Fort Worth, TX 76102-3922

Gentlemen:

Reference:

a. Your Contract Number DACA63-94-D-0015, Indefinite Delivery Contract for Architect Engineer Services Primarily for Master Planning Type Projects Assigned to the Fort Worth District.

b. Delivery Order Number 0009, to provide A-E services for FY 96, Energy Study (EEAP), HELSTF Facility, White Sands Missile Range, New Mexico.

The Pre-Final Submittal for the referenced project is approved subject to incorporating the enclosed comments.

If you feel that any of the comments require effort on your part, which is outside the original scope of the referenced delivery order, please contact this office immediately. These comments will not be accomplished without prior approval from this office. Two copies of the comments, depicting your annotated response/action, should be returned to this office within seven calendar days after receipt of this letter. Your annotated response should also identify conflicts in review comments which must be resolved prior to the next submittal.

You are to proceed with the preparation and submittal of the Final Submittal per the referenced delivery order and are to incorporate all comments into this next submittal, except those comments described in the preceding paragraph.

In accordance with the Scope of Work for the referenced delivery order, the Final Submittal is due within 40 calendar days after receipt of this letter. Your transmittal letter of the Final Submittal must include a certification that the documents have been subjected to your own review and coordination procedure to ensure:

a. Completeness for each item to be studied

b. Elimination of conflicts, errors and omissions

c. The overall professional and technical accuracy of the study

Please complete the enclosed endorsement and return a copy to this office (ATTN: CESWF-ED-MR). Should there be any questions, please contact Mr. Noah Booker, Jr., Engineering Manager, at (817) 334-2763.

Sincerely,

Bernard Hamilton, P.E.
Contracting Officer's
Representative

Enclosures

ENDORSEMENT

Receipt of authorization to proceed with the Final Submittal for FY 96, Energy Study (EEAP), HELSTF Facility, White Sands Missile Range, New Mexico.

This document was received: Date 7/15/96

By [signature]

Title Vice President

HUITT-ZOLLARS

Huitt-Zollars, Inc. / Engineering / Architecture / 512 Main Street / Suite 1500 / Fort Worth, Texas 76102-3999 / Phone (817) 335-3000 / Fax (817) 335-1025

July 23, 1996

Mr. Noah Booker
ATTN: CESWF-ED-MR
US Army Corps of Engineers
P.O. Box 17300
Fort Worth, TX 76102-0300

**RE: LIMITED ENERGY STUDY, HELSTF, (EEAP)**
**WHITE SANDS MISSILE RANGE, NM**
**MARCH 6, 1996 "PRE-FINAL REPORT" REVIEW COMMENT ANNOTATIONS**
**HZ PROJECT 03-0185.05**

Dear Mr. Booker:

Transmitted herewith is one copy of the review comment annotations for the Pre-Final Report phase of the project. Based on our receipt of the NTP on July 15, 1996, the Final Report is due on or before Friday, August 23, 1996.

It will be assumed that these annotations are accepted as stated unless notice to the contrary is brought to my attention within one week following receipt of this letter. If you have any questions or require further assistance on this subject, please let me know. Thanks!

Sincerely,

**HUITT-ZOLLARS, INC.**

Denney R. Howard

Denney R. Howard, P.E.
Project Manager

DRH:ph

Enclosure(s)

cc: Julian Delgado, STEWS-DPW-PE, w/Enclosure(s)
Allen Bennett, CSSD-EN-F, w/Enclosure(s)
Anthony Battaglia, CESAM-EN-DM, w/Enclosure(s)
Larry Brooks, CSSD-HD, w/Enclosure(s)

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## ***** REVIEW COMMENT ANNOTATIONS *****

### MAY 6, 1996 "PRE-FINAL REPORT"

| | |
|---|---|
| CLIENT: | US ARMY CORPS OF ENGINEERS |
| PROJECT: | LIMITED ENERGY STUDY, HELSTF, (EEAP) |
| PROJECT NO.: | 03-0185.05 |

Following are the annotations of project review comments on the Pre-Final Report submittal. It will be assumed that this understanding is correct unless notice to the contrary is brought to the attention of the HZ Project Manager within one week following receipt of these annotations.

| | |
|---|---|
| HZ | = Huitt-Zollars, Inc. |
| COE | = US Army Corps of Engineers |
| HELSTF | = High Energy Laser System Test Facility |

**A. Anthony W. Battaglia, CESAM-EN-DM, 06 June 96**:

1. Concur.
2. Concur. The cost for diesel will be corrected in Figures 1 and 8 and associated references to these figures.
3. Concur.
4. Concur. This change will be reflected in the savings calculations.
5. Concur. The recommended boiler is ULFM listed for both natural gas and propane, but we will recommend a detection system and alarm for the boiler room and will include that in the cost estimate.
6. Concur. Equipment description on Page B-127 will be changed to agree with ECO description on Page B-124.
7. Concur. A cost associated with abating the asbestos materials will be incorporated in the final report.

**B. George Culpepper, CESWFED-TM, 3 June 96**:

1. Concur.
2. Concur. This subject will be clarified in the Final Report.

**C. Aerotherm Facilities Support Group (Ken Timblin & Frank Tapia), Aerotherm, 19 June 96**:

1. Concur.
2. Concur.

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3. Concur. This design will take extensive coordination between the design team, owners, and facilities personnel.
    a. Concur.
    b. Concur.
    c. Exception. It is not required that the Army change the temperature and humidity setpoints for Test Cell # 1. The ECO is still valid regardless of the change in temperature and humidity requirements. However, it is strongly recommended that the ARMY verify its current requirements vs. newer technology.

4. Concur. The cost estimate and description of the ECO will be modified from 56 retrofit boxes to 112 VAV retrofit boxes. This will allow the design for two boxes per zone or heating coil if needed.

5. Concur.

6. Concur.

7.
    a. Concur. This description will be modified in the final report.
    b. Concur. This description will be modified in the final report.

8.
    a. Concur. This description will be modified in the final report.
    b. Exception. Under the requirements of this study, it would be cost prohibitive to replace both boilers, being that one of the boilers is used for stand-by purposes. **However**, we do agree with the comment and think that it is in the best interest of HELSTF and the Facilities Support Group that both boilers be replaced.
    c. Exception. The manufacturer of the boilers state that polypropylene glycol does not cause premature deterioration to the boilers if the glycol solution is inhibited; does not contain petroleum based additives; and does not contain over 50% glycol.
    d. Concur.
    e. Concur. For expansion purposes, we will recommend a 1200 MBH-output boiler.

**D. Margaret Danao, Aerotherm, 01 Mar 96**:

1. Concur.

2. Concur.

3. Concur.

4. Concur.

5. Concur.

6. Concur.

7. Concur.

8. Exception. See response for C.8.b. above.

I:\proj\030185.05\admin\letters\booker3.ltr

E. **Jim Rosser, Aerotherm, 01 Mar 96:**

1. Concur.

2. Concur.

F. **Julian T. Delgado, STEWS-DPW-PE, 31 Jan 96:**

1. Concur. We will incorporate the 1996 melded rate into the final report.

2. Concur.

END OF REVIEW COMMENT ANNOTATIONS

I:\proj\030185.05\admin\letters\booker3.ltr

| MOBILE DISTRICT PROJECT REVIEW COMMENTS: | | DATE: 06 June 1996 | Page 1 of 1 |
|---|---|---|---|
| TO: Noah Booker, CESWF-ED-MR<br>USAED, Fort Worth, Texas | | FROM: Anthony W. Battaglia, CESAM-EN-DM<br>Phone: (334) 690-2618 FAX: (334) 690-2424 | |
| PROJECT/FY: FY95 Limited Energy Study, HELSTF | | | |
| LOCATION: White Sands Missile Range, New Mexico | | | |
| TYPE REVIEW: Pre-final Submittal | | | |

| . | Page/Par | COMMENT | Response to Comment |
|---|---|---|---|
| 1. | General | On the binder inserts and title pages, change "Fort Worth Division" to "Fort Worth District". | |
| 2. | Pg 2 | In Figure 1, the cost shown for Diesel appears to be incorrect; it should be on the order of $121,000. Please check and correct. | |
| 3. | Pg 18 | Par. 1, Machine Type: The second sentence has a typo and does not make sense. Please correct and clarify. | |
| 4. | Pg A-2 | The calculation for the avoided cost of Diesel is incorrect. The heating value of Diesel is 138,700 BTU/Gal, or 7.21 Gal/MMBTU. This would result in a cost of approximately $7/MMBTU. Please check and correct. | |
| 5. | Pg B-106 | Consider that the specific gravity of gaseous propane is 1.5, ie, heavier than air; and that the location of the new boiler is in the basement of the LSTC. Would this require any special safety cnsiderations; and, if so, have they been included in the cost estimate? | |
| 6. | Pg B-127 | The equipment list shows two boilers and propane fuel. This does not agree with the ECO description on page B-124. Please correct. | |
| 7. | Pg B-130 | Existing boiler demolition: From our discussion in the interim review meeting, there is at least a small amount of asbestos present in the existing boilers. This would require at least some minimal precautions during demolition. This should be mentioned in the write-up; and allowance should be made in the estimate. | |
| | | END OF COMMENTS | |

Compliance check for Energy Study at HELSTF, ESEEAPHF

File: i:\culpep_g\CMESEEPH.DBF

| Num | Name | Office | Page/Sheet | Discipline | Rm/Detail |
|---|---|---|---|---|---|
| 1 | CULPEPPER,GEO. | CESWFED-TM | ONE-OF-ONE | MEC | ALL |

1. The five comments made on my previous review have been addressed and responded to in a satisfactory manner.

2. I will however take strong exception to the information presented on pages 16 and 17 under "Utility Data", in the Pre-Final Report, Volumn I dated 5/6/96. A resolution must be reached between Huitt-Zollars, Inc. and the responsible parties at the facility concerning the Energy Consumption of both electricity and diesel fuel. Alluding to billing errors in this report is not acceptable and must be resolved prior to the final report.

# Aerotherm Facilities
# Support Group
# Lead Man; Ken Timblin
# Technician; Frank Tapia

19 June, 1996

Subject: Pre-Final Energy Audit Comments

1 Eco-A Ok

2 Eco-B Ok

3 Eco-C a. Comment; Energy management system's are great. The design of an EMS in the LSTC is going to be one of the biggest challenges on this site. Even though some of the AHU's are of a simple design, their duct systems are not quite that simple. Some area's in the LSTC that were covered by a certain AHU, are no longer covered by that unit because a wall might have been built to separate the areas. Some duct work stretches out so far into the building, that the offices at the tail end of that AHU suffer. If temperatures are to be satisfied at the tail end, the offices in between suffer.

Item # 7, Pp B-68

b. AHU's that have outside air intakes and have humidifiers on them operate properly. When outside air is below 50 °F the chilled water valve closes. A thermostat controls for temperature 70°f +/- 2°. A humidistat controls the humidity to 40% +/- 5%. A second humidistat controls the chilled water valve for dehumidifying. When the second humidistat calls for dehumidifying, the first humidistat is satisfied and the humidifier is shut down.

c. The temperature and humidity requirements for TC-1 will have to be changed by the Army, or responsible persons in charge of TC-1, before ECO is implemented.

4 Eco-D Variable air volume systems are a good idea and again will entail extensive engineering design challenges in the LSTC.

Note: All AHU's in the LSTC have a return air system by means of duct work or just open to one main area. (example) AHU-1, a multi-zoned unit supplies conditioned air to the Library that has been divided into a Weight room, HVAC/ELECT control room , Commo, Janitor's room and I & C lab. Temperatures in these area's are controlled by thermostats which open and close a damper on the AHU. I & C has its own thermostat. The Library and Weight rooms share a thermostat located in the Weight room.

The HVAC control room, the Commo room & the Janitor break area share one (1) thermostat located in the HVAC control room.
All return air to the unit is by an opening in the walls to the main hallway.

Each multi-zone AHU is designed in the same manner for the zone it covers. The zones are then divided into different area's and area's into different spaces.

Single-zone AHU are also designed in the same way in some zones. AHU-4, is the only AHU that supplies the computer floor and returns back to AHU 4.

not VAV will need to be installed to the different offices or room area's and the branch duct for that zone. This could bring the # of VAV's up from 56.

5 Eco-E Ok

6 Eco-F Ok, the concept is good and incorporates a backup system.

7 Eco-G Ok on replacement

a. B. All pumps that are designated for future use should be removed from the system.
example; cooling tower sump p-65 & 66
Condenser pumps p-58 & 59 are in the process of being removed.

We agree on by-passing and keeping in the line p-60 & 61.

b. c. There is no chilled water being used in TC-2.
Condenser tubes on CH-51 & 52 were Eddy-current tested. Test results made it possible for us to determine wear on the tube bundles. Those tubes that were rated with extreme wear, were plugged up to protect the refrigeration cycle from water contamination if the tubes were to wear through . There are no clogged tubes only plugs. Condenser water system in TC-2 is unique, but the system is more like a parallel-series' system rather than just a series.

Note: Cooling tower pumps P-65 & P66 are tied into one main header, making them parallel so that both pumps can be operating at the same time pumping water into the same header. The header is tied into one 8" line that goes into TC-2. From that line there are 4 ea., 8' taps. One tap for each of 4 pumps (P-60-61 /P-58-59). Condenser pumps P-60 & 61 are in series to the cooling tower pumps P-65 & 66. P-60 & 61 guarantees that the condensers on

CH-51 & 52 get the full 525 GPM flow required to keep the chillers operational. They serve as a buster pump for the chillers. Condenser water pump P-58 &59 are also in series with the
cooling tower pumps P-65 & 66. They have nothing to do with P-60 & 61. Their only function is as stated but are no longer used, and are being removed from the system. P-58 & 59 are parallel to each other. P-60 & 61 are also parallel to each other.

8 Eco-H a. We have never set boiler temperature as high as stated. Boiler loop temperatures are maintained at 180-190°F Hot water loop
temperature at the heat exchanger has to be no less than 160°F continuous.
Boiler loop temperatures are set to maintain 160°f or better at the heat
exchanger, no more that 180°F.

b. The replacement of 1 ea. Boiler is still not a good idea from our point of view. We will have to stock and carry parts for 2 different units. If ever a time came where we needed to switch parts around to meet deadlines, which has happened in the past, parts will not be interchangeable
We will eventually have to go through replacement and removal of the old unit, as well as the redesign of the system. There is the possibility of not being able to locate a new unit of the same make and model as the one being replaced at this time. We will then still be stuck with diesel units instead of propane.

Note; Mr. Julian Delgado, is it possible that HELSTF will ever be
able to get natural gas out here? If so, propane units would be the way to go, because they are easier and cheaper to convert to
natural gas.

c. Removing the heat exchangers is a good idea, but we will still have a sectional boiler on line. We do not think that the asbestos gaskets on this unit will withstand any type of glycol solution and will deteriorate even faster.

d. Replacing ethylene glycol with polypropylene glycol is a great idea. This should be done to all freeze protected chilled and hot water systems on site.

e. The system should be designed to the Btu /hr., which we are replacing,
with more efficient equipment. This will give us room for expansion of the system.

96MD04 - 7/8/96 - p. 4

96-MD18
21 June 1996

**TO:** Larry Brooks

**FROM:** Margaret Danao

**SUBJECT: Energy Study (EEAP) at HELSTF Facility, Pre-final Report**

Again, I commend Huitt-Zollars Inc. (HZ) on the excellent job that they did in performing the study. I like the changes which have been applied to the ECOs and I agree with "Table 2: HELSTF ECO Priority List" (p. B-130). Below, I give comments about each ECO.

1 **ECO-A, Lighting Fixture Upgrade:** Good

2 **ECO-B, Occupancy Sensors for Lighting Controls:** Good.

3 **ECO-C, Energy Management System for HVAC Controls:** Good. This should be done in conjunction with ECO-D. Extensive engineering and re-design of the HVAC system will be required for this ECO.

4 **ECO-D, VAV Controls Retrofit:** See comments for ECO-C.

5 **ECO-E, High Efficiency Motor Retofit:** Good.

6 **ECO-F, Chiller Retrofit at LSTC Building:** Good. I agree with the backup.

7 **ECO-G, Chiller Retrofit at Test Cell 2 Building:** Good. I agree with the backup.

8 **ECO-H, Boiler Retrofit at Test Cell 2 Building:** I understand why HZ is proposing the diesel boiler under the limits of the energy audit. However, I recommend that two propane-fired hot water boilers as the best alternative for the HELSTF site since natural gas is not available. Propane boilers are easier to maintain and are more energy efficient than diesel boilers. From a design and construction standpoint, it would be more cost effective to replace both boilers at the same time.

Thank you for the opportunity to review the energy audit. If you have any questions, please call me.

Margaret Danao
Mechanical Engineer, Laser, Optics and Test Department

cc: J. Skipper DATE:
06/20/96

96MD04 - 7/8/96 - p. 5

TO: LARRY BROOKS

FROM: JIM ROSSER

SUBJECT: ENERGY AUDIT PRE-FINAL REPORT COMMENTS

1 Huitt-Zollars has done an excellent job of incorporating all of the comments and recommendations that were suggested during the review meeting. The report includes added labor for ECOs A and B as requested as well as the proper cost of electricity that HELSTF is being charged. The net result in each of the projects was an increase in SIR and a decrease in Simple Payback with a net savings of approximately twice that of the first report. They also provided a list in the report of how HELSTF personnel would prioritize the projects based on need as opposed to plain economics.

2 Although my comments are limited, I recommend that funding for these projects proceed as soon as possible in order to maximize the benefit of their operation.

| ENGINEERING REVIEW COMMENT | WHITE SANDS MISSLE RANGE | SHEET 1 OF 1 |
|---|---|---|

PROJECT TITLE: ENERGY STUDY (EEAP) AT HELSTF

ITEM NO.

☐ PRELIM ☐ FINAL ☑ PRE-FINAL

☐ CIVIL ☐ ARCH. ☐ STRUCT.

☐ MECH. ☑ ELECT. ☐ SPECS.

☐ EST. ☑ Energy ☐

BY Julian T. Delgado

DATE 09 July 96

A. CONCUR
D. DO NOT CONCUR
E. EXCEPTION SEE COMMENT
X. DELETE COMMENT

| DWG Or PAGE NO. | CMT. NO. | COMMENTS | ACTION BY WS | | SWD |
|---|---|---|---|---|---|
| | | VOLUME I | | | |
| A-1 | 1 | Due to an oversight by this reviewer, the melded electric rate should be \$0.0852/KWH for Calendar Year 96 charges. The rate indicated, \$0.0821/KWH is for Calendar Year 1995. | | | |
| A-1 | 2 | The rate for Propane Gas is correct for Calendar Year 96 charges (\$0.6760/gallon). | | | |
| | | Julian T. Delgado<br>Energy Management Coordinator | | | |

STEWS-IS Form 24
1 Mar 86

Replaces STEWS-FE Form 11, 1 Dec 73, which is obsolete.

# HUITT-ZOLLARS, INC.

512 MAIN STREET, SUITE 1500
FORT WORTH, TEXAS 76102
(817) 335-3000

## FACSIMILE COVER SHEET

DATE: 7/29/96 HZ JOB NO: 03-0185.05

NUMBER OF PAGES (Including this cover sheet): 3

TO: COMPANY NAME: US Army Corps of Engineers

ATTENTION: Noah Booker, Jr.

FAX NUMBER: (817) 978-3348

FROM: HUITT-ZOLLARS, INC.

BY: Denney R. Howard, P.E. DRH

OUR FAX NUMBER: (817) 335-1025

NOTES / COMMENTS:

Noah,

Please find attached the corrected versions of pages 16 &17 for the HELSTF Final Report. I hope this addresses Mr. Culpepper's comments.

If you have additional questions or need more information, please call me at (817) 335-3000. Thanks!

SENT BY: Denney Howard TIME: 11:00 AM DATE: 7/29/96

CC: file

*If you have any problems receiving this fax, please call us at (817) 335-3000.*

072996FX.XLS

effort to identify nonessential equipment that can be turned off, especially at night and on weekends, should be made in the LSTC and TC-1 buildings. This could potentially save thousands of dollars a year at little or no cost to the facility.

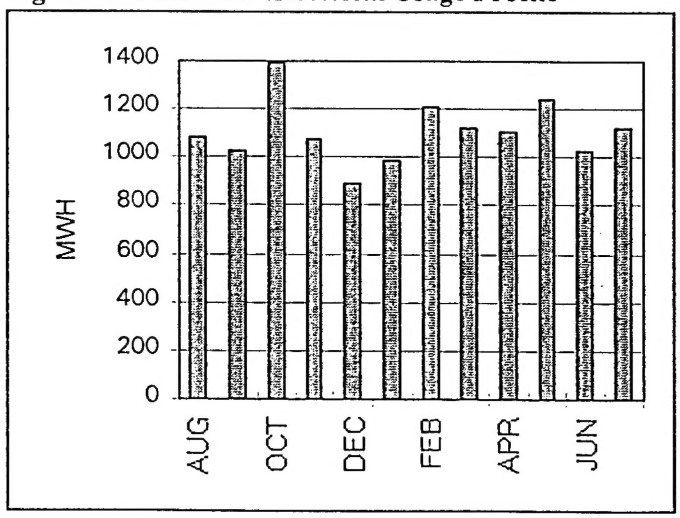
Also, at the TC-2 building, the compressed air systems are in operation 24 hours a day, year round. Just as with the electronics equipment mentioned previously, an effort should be made to turn this equipment off at night and on the weekends. As the compressed air systems are used for test-related equipment in the test cell area, a study by the facility staff would be required to identify periods when they could be safely turned off.

*Utility Data:* A recent 12-month utility billing history was obtained from the facility staff and is shown in Figure 8. This data can be used as a benchmark to compare the computer simulations output for the facility. Moreover, this 'base year' history included an estimation of the electric consumption for the site, as well as all delivered liquid propane and diesel fuel (heating usage only) during the period of October 1994 through September 1995. The facility does have an electrical meter serving the LSTC building and that is assumed by the base to be 80% of the total consumption for HELSTF. The electric service is provided by the El Paso Electric Company (EPEC), and the liquid propane and diesel fuel are provided by local suppliers. All of these utilities are currently billed to HELSTF through the U.S. Army at the White Sands Missile Range. The total cost of electricity for the base year was $1.07 million and the total cost for liquid propane and diesel fuel was $157 thousand.

**Figure 8. Base Year Utility Data**

| Billing Period | Electrical Usage MWH | Electrical Cost $ | Diesel Usage Gallons | Diesel Cost $ | Propane Usage Gallons | Propane Cost $ |
|---|---|---|---|---|---|---|
| AUG | 1,078 | 88,484 | 11,500 | 11,155 | 410.2 | 285 |
| SEP | 1,023 | 84,010 | 11,833 | 11,478 | 5290.5 | 3,672 |
| OCT | 1,390 | 105,244 | 15,074 | 14,622 | 4376.0 | 3,037 |
| NOV | 1,076 | 81,457 | 16,860 | 16,354 | 8705.8 | 6,042 |
| DEC | 893 | 67,594 | 13,055 | 12,663 | 17714.2 | 12,294 |
| JAN | 986 | 80,978 | 16,500 | 16,005 | 3405.8 | 2,364 |
| FEB | 1,211 | 99,435 | 6,062 | 5,880 | 7036.9 | 4,884 |
| MAR | 1,125 | 92,340 | 5,000 | 4,850 | 2150.3 | 1,492 |
| APR | 1,109 | 91,052 | 6,083 | 5,901 | | |
| MAY | 1,241 | 101,851 | 5,000 | 4,850 | | |
| JUN | 1,029 | 84,478 | 13,000 | 12,610 | | |
| JUL | 1,120 | 91,919 | 5,000 | 4,850 | 2025.0 | 1,405 |
| Total | 13,281 | 1,068,842 | 124,967 | 121,218 | 51114.7 | 35,475 |

**Figure 9. Base Year Electrical Usage Profile**




A graph of the base year electrical energy usage is shown in Figure 9. Looking at the graph, the consumption does not follow a typical curve for a facility that utilizes alternative heating fuel. There are a couple of reasons for this. One is that the testing schedule for HELSTF is sporadic and the testing process consumes a significant amount of energy. Furthermore, during the "Base Year", not only did the main transformer explode, but the base also lost the capabilities of one of the central meters. Therefore, both the EPEC and White Sands Missile Range decided to estimate the consumption during this time on historical data.

Modified to address billing method.

No billing errors have been assumed.

A graph of the base year diesel fuel usage is shown in Figure 10. This profile is very unusual, but perhaps reflects that diesel fuel is used for space and process heating or reflects the other users besides HELSTF. The variation of monthly fuel deliveries indicates that heavy process heating was required from August through January, and again in June. The fuel deliveries in the other months, while approximately half as much as before, are still excessive. This is possibly an indication of inefficiencies in the diesel fired heating systems, as well as continuous operation of this equipment. In either case, it seems to indicate that the potential for diesel fuel savings is significant at HELSTF.

**Figure 10. Base Year Diesel Usage Profile**

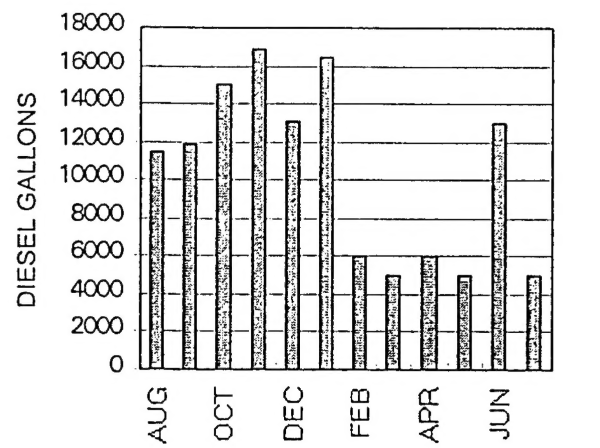
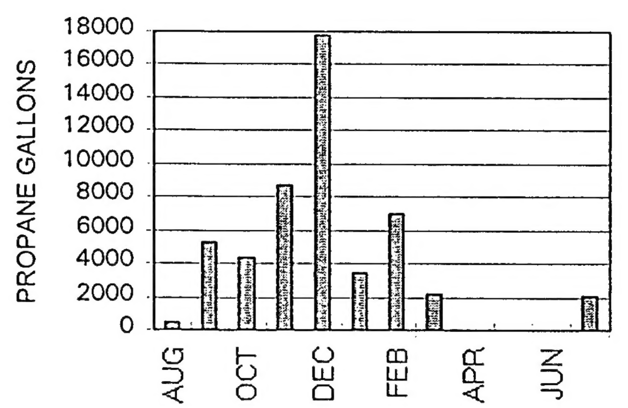



**Figure 11. Base Year Propane Usage Profile**




A graph of the base year liquid propane usage is shown in Figure 11. This profile is more typical for a heating fuel, with an annual 'heating hump' during the winter season, and minimal or no usage the rest of the year. In the buildings included in this study, there is currently no propane usage. However, this study will recommend using propane fired boilers if applicable.

The current electric utility rates from EPEC, as well as the current costs of propane and diesel, were obtained during the audit and are included in the Appendix A. The current avoided cost for electrical savings is $0.083 per KWH. For diesel fuel savings the avoided cost is $0.97 per gallon, and for liquid propane savings the avoided cost is $0.676 per gallon.

*Replacement Boiler Selection*: Data on available replacement boilers were obtained from typical manufacturers in order to select representative boilers for ECO evaluations. This data included performance characteristics, physical dimensions and cost figures. The criteria for selecting new boiler systems for the ECOs are described below.

1. Efficiency. Replacement boilers that had the highest overall efficiency over the operating range were selected in each area. In most cases, this criteria was met by the high-efficiency modular boilers which were modeled in the ECOs. These are fully condensing, forced draft firetube units that have efficiencies to 99 % in part load operation. No other boiler type was found to match this performance.

US ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

**FACSIMILE TRANSMITTAL HEADER SHEET**

FROM: NOAH BOOKER, JR. CESWF-ED-MR (817) 978-2763
CESWF-ED-M FAX (817) 978-3348

TO: MR. DENNEY HOWARD HUITT-ZOLLARS (817) 335-3000
FAX (303) 335-1025

PLEASE NOTIFY ABOVE RECIPIENT UPON RECEIPT

SUBJECT: LIMITED ENERGY STUDY, EEAP - HELSTF, WSMR, NM

THIS SHEET + 1 PAGES DATE: 29 Jul 1996

COMMENTS:

Project: LIMITED ENERGY STUDY, HELSTF, (EEAP)
Project No.: 03-0185.05
29 July 1996

Reference: Pre-Final Report review comments resolution by Mr. Denney R. Howard, P.E.

My comments on 3 June 96 were addressed and all but two resolved to my satisfaction. These two were both concurred with but one was left open until the final report was published. I do not doubt that it will be resolved in the end but I would hope that the answer could be published prior to a final report.

Since the comment involved the Utility Cost and all the justifications were based on these costs it would appear to me that any questions about them must be resolved and agreed upon prior to the publishing of the Final Report.

A fax, memo or some other type of written informal verification would be satisfactory if agreeable to all to prevent the delay of the publishing of the Final Report.

I can not stress enough the importance of getting the Economics correct and agreed upon prior to proceeding with the final step of this project.

George V. Culpepper, P.E.